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Norms in French for 209 images of the "food-pics" image database

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ABSTRACT

We provide norms collected on a sample of French adults for a subset of 209 food images selected from the *food-pics* image database (Blechert, Meule, Busch, & Ohla, 2014). The pictures were rated on arousal, familiarity, valence, liking, frequency of consumption, caloric content, healthiness, tastiness, desire to eat and perceived level of transformation. Reliability measures were computed for the norms. Descriptive statistical analyses and correlational analyses were performed. The entire set of norms, which will be very useful to researchers investigating the cognitive/emotional processing of food (e.g., food perception) and the determinants of eating behaviors, is available as Supplemental Material.

1. Introduction

Food has always been essential for humans (Foroni, Rumiati, Coricelli, & Ambron, 2016). In the distant past, humans lived in environments where food was often scarce and its availability was uncertain (Swaffield & Roberts, 2015). Thus, our remote ancestors had to hunt and to gather food on a regular basis[1]. Natural selection has built a propensity to over-eat when food is readily available as well as the ability to store excess energy as fat (Swaffield & Roberts, 2015). As a result, we have evolved taste preferences for foods which provide rich sources of calories, such as sweet foods (Hall, 2016; Herz, 2018; Krebs, 2009) or fatty foods (Hall, 2016). The mechanisms that helped our ancestors to survive in environments where fat and sugar were scarce resources are still activated in modern environments where this type of food is readily available in great quantities (e.g., hamburger, French fries, pizza), potentially leading to maladaptive behaviors. This mismatch could be in part responsible for the epidemic of obesity that modern societies are facing (Berbesque & Marlowe, 2009). Even though finding food is no longer a critical concern in most modern industrialized societies because food can be easily bought in supermarkets or in fast-food restaurants, it is still a daily concern and it represents an important part of people's financial budget. For examples, according to Rozin (1996), food corresponds to 21% of the income in Germany and in the United States and 50% in India and China.

1.1. Food processing and preferences

According to evolutionary psychologists, items that are important for survival and/or reproduction are given processing priority compared to items that are not fitness-relevant (Buss, 2019) and foods are such items.

At a cognitive level, there is good evidence to suggest that food holds special sway. For instance it has been shown that food items are detected faster than non food items (e.g., Sawada, Sato, Toichi, & Fushiki, 2017) and high-calorie foods have a highly distracting impact in categorization tasks even when non-consciously perceived (Cunningham & Egeth, 2018; see also Foroni et al., 2016). Turning to the brain level, the distinction between food and nonfood is encoded very rapidly at the neural level (Tsourides et al., 2016). High-calorie food activates the left orbitofrontal cortex, which is part of the reward system in the brain, and the right insula/operculum (Simmons, Martin, & Barsalou, 2005). An fMRI study found that both high- and low-calorie food were associated with bilateral activation of the amygdala and ventromedial prefrontal cortex (Killgore, Young, Femia, Bogorodzki, Rogowska, & Yurgelun-Todd, 2003). High-calorie foods led to activation within the medial and dorsolateral prefrontal cortex, thalamus, hypothalamus, corpus callosum, and cerebellum. Low-calorie foods resulted in a lower level of

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[1] Because food has always been (and still is) of great relevance for survival, it seems tempting to believe that there has been plenty of research dedicated to the investigation of food-related behaviors, in particular within an evolutionary perspective. However, just the contrary is true (Rozin & Todd, 2016). Studies on food-related behaviors in healthy people are indeed relatively new.

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activation within the medial orbitofrontal cortex; primary gustatory/somatosensory cortex; and superior, middle, and medial temporal regions. To investigate the cognitive processes and/or their neural correlates, a wide variety of food images are used as a proxy for real foods. Across studies, these images may vary along a number of dimensions such as the presence/absence of background to display food (e.g., single items, pots with food), photographs of food in color or in black-and-white. Such variability may complicate the comparison between studies.

Food preferences vary widely among individuals and, to some extent, among certain categories of people. Padulo et al. (2017) found that women had a stronger preference for fruits and vegetables than men (see also Rozin, Hormes, Faith, & Wansink, 2012; Egolf, Siegrist, & Hartmann, 2018), and that not only children or adolescents but also elderly people had a preference for sweet food. Men, more than women, prefer to consume meat (Rozin et al., 2012). Young children do not eat much vegetable (Heath, Houston-Price, & Kennedy, 2011). Food preferences are largely learned through conditioning and social learning (Lafraire, Rioux, Giboreau, & Picard, 2016). Disgust—an emotion that signals that a food item must be avoided or expelled if ingested (Schnall, Haidt, Clore, & Jordan, 2008)—certainly plays a role in the acquisition of food preferences. Indeed, evidence suggests that food preferences and, more generally, eating behaviors, are shaped by individuals' differences in food disgust sensitivity (Ammann, Hartmann, & Siegrist, 2018; Egolf et al., 2018)[2].

It is important to keep in mind that the mechanisms responsible for food consumption are not activated in a rigid manner but are, instead, subject to contextual influences. To illustrate, in the lab, when people are exposed to cues representing a harsh environment, they tend to prefer energy-dense food items, whereas they exhibit a decreased desire for energy-dense food items following exposure to cues indicating a relatively safe environment (Laran & Salerno, 2012; Swaffield & Roberts, 2015). Also, individuals do not eat the same amount of food when they eat with other people as when they eat alone (Hetherington, Anderson, Norton, & Newson, 2006). And certain types of food are consumed more frequently when individuals feel lonely, i.e., "comfort food" (Troisi & Gabriel, 2011).

Again, to investigate food preferences and their determinants, food images are often used. As stated above, if the images that are used are too variable across studies, this introduces "noise", potentially compromising the reliability and validity of the findings (Charbonnier, van Meer, van der Laan, Viergever, & Smeets, 2016). As a result, this may hamper the comparisons that can be made between studies.

1.2. The utility of standardized pictures of food to study food processing

Until very recently, standardized pictures of food were lacking. In effect, if researchers have to search for pictures of food to design studies on food processing, it is likely that the findings will prove difficult to replicate because of the idiosyncratic properties of the stimuli used from study to study. Rumiati and Foroni (2016) had already noted that, as far as the question of how food information is stored in the brain is concerned, the discrepancy between the findings in the literature has to do with methodological problems related to stimuli: "(…) *the number of food stimuli employed in the reviewed studies was in many instances too small, the stimuli belonging to the different categories did not always match for relevant variables, and different patients were tested with different stimuli.*" (p. 1049). Thus, having norms on food items permits the design of research with items that are matched on relevant dimensions, while databases of food stimuli provide a common basis for comparing the findings from different studies (Tsourides et al., 2016). Moreover, if the same set of pictures of food is used worldwide, the findings obtained from different labs can be more reliably compared.

Norms on a large set of pictures of food are relatively scarce compared to norms on pictures corresponding to more general categories of objects (e.g., Snodgrass & Vanderwart, 1980). Even though the frequently-used Snodgrass and Vanderwart database comprises pictures of food, there are not many of them. Indeed, there are only 24 drawings of (non-transformed) food (11 fruits, 13 vegetables). One of the normative studies dedicated to pictures of food is the Italian food database, i.e., FRIDa for FoodCast Research Image Database (Foroni, Pergola, Argiris, & Rumiati, 2013), which provides norms for several categories of food (99 natural foods, 153 transformed foods, and 43 rotten foods) and 582 non-food images (e.g., objects). The pictures of food were rated on several "general" subjective dimensions (e.g., valence, arousal, familiarity) as well as on "food-specific" dimensions (perceived calorie content, perceived distance from eatability, perceived level of transformation). Finally, information on the visual characteristics of the pictures (e.g., brightness) is also provided.

The "food-pics" image database is another standardized, freely available image library which was originally validated in a large sample, primarily consisting of adults (Blechert et al., 2014; see also the extended database: Blechert, Lender, Polk, Busch, & Ohla, 2019). Blechert et al.'s (2014) database comprises 568 food images and 315 non-food images. The food pictures have been rated by German-speaking adults and by American-English-speaking adults on the dimensions of valence, arousal, palatability, desire to eat, recognizability and visual complexity. Importantly, objective characteristics are also available, such as data on macronutrients (g), energy density (kcal), and detailed physical image characteristics (e.g., complexity, contrast, brightness). Image characteristics permit the strict control of visual properties when designing experimental studies. Recently, Prada, Rodrigues, Garrido and Lopes (2017) collected norms for a subset of 210 food images selected from *food-pics* (Blechert et al., 2014). The pictures were rated by Portuguese adults on arousal, familiarity, valence, liking, frequency of consumption, caloric content, healthiness, tastiness, desire to eat and perceived level of transformation. The "food-pics" database has recently been increasingly used to investigate several issues pertaining to food processing (e.g., Cunningham & Egeth, 2018; Horne, Palermo, Neumann, Housley, & Bell, 2019; Kirsten, Seib-Pfeifer, Koppehele-Gossel, & Gibbons, 2019), and it has also been normed in adolescents (Jensen, Duraccio, Barnett, & Stevens, 2016).

It is important to note that there are other food databases in the literature that have been published more recently. Likewise, the Open Library of Affective Foods (OLAF) was published by Miccoli, Delgado, Rodríguez-Ruiz, Guerra, García-Mármol, and Fernández-Santaella (2014). It includes 96 pictures of food that were normed by Spanish adults on valence, arousal, dominance and food craving. Charbonnier et al. (2016) collected norms in both adults and children for high-resolution photographs of pictures (N = 370) on the dimensions of recognizability, liking, healthiness and perceived number of calories in different European countries (e.g., Greece, Netherlands, Sweden). The macronutrient picture system (MAPS) developed by King et al. (2018) has been used to collect norms on interest, appetite, nutrition, emotional valence, liking and frequency based on a limited set of pictures (N = 144), and, interestingly, detailed macronutrient composition, is provided for the food items. Even more recently, Toet et al. (2019) collected norms on a set of 479 photographs of food in 2019. The images were rated on the valence, arousal, desire-to-eat, perceived healthiness, and familiarity dimensions. The database includes photographs of both Western and Asian cuisines. In the database, there are also pictures of food that vary on the appetitiveness dimension (e.g., moldy or rotten

[2] States of homeostatic imbalance—hunger, thirst—have been found to alter the level of disgust for unpalatable foods, with the result that hungry adults express less disgust in response to pictures of unpalatable foods compared to satiated controls (Hoefling et al., 2009) and the same phenomenon has been found in thirsty participants (Meier et al., 2015). Also, certain food preferences can contingently shift as has been found among pregnant women during the first trimester (Fessler, Eng, & Navarrete, 2005); the function of disgust and nausea towards certain types of food (e.g., meat) would be to protect the fetus from teratogens (Flaxman & Sherman, 2000; Profet, 1992).

food, fresh food).

To our knowledge, there are no published norms on pictures of food in French in sharp contrast with other types of pictures such as pictures of objects (Alario & Ferrand, 1999; Bonin, Peereman, Malardier, Méot, & Chalard, 2003; Bonin, Poulin-Charronnat, Lukowski Duplessy, Bard, Vinter, Ferrand, & Méot, 2020). Following Prada et al.'s (2017) study, we collected exactly the same subjective ratings as used by Prada et al. (2017) on exactly the same set of 210 food images, that is to say arousal, familiarity, valence, liking, frequency of consumption, caloric content, healthiness, tastiness, desire to eat and perceived level of transformation. Indeed, the current study was conceived as an extension to French culture of the Prada et al. (2017) study. Likewise, these norms will fill a gap in the literature on norming studies in French. The norms should be useful for researchers who are interested in the proximate mechanisms involved in food processing in adults (e.g., memory for food: de Vries, de Vet, de Graaf, & Boesveldt, 2020), the determinants of eating behaviors (e.g., Hetherington, Anderson, Norton, & Newson, 2006; Laran & Salerno, 2013; Seitz, Blaisdell, & Tomiyama, 2021; Swaffield & Roberts, 2015; Troisi & Gabriel, 2011). The normed pictures will be useful to investigate differences among categories of people (e.g., older versus young adults), but also cultural differences, and even regional differences in food consumption within the same country (e.g., north versus south of France). For researchers who want to have at their disposal some non-food control pictures, we decided to collect norms on a set of 97 non-food pictures which are provided in the Supplemental Material However, because our focus is on food, the associated non-food data were not analyzed.

2. Method

2.1. Participants

A total of 127 participants from the University of Bourgogne (mean age: 19.21 years; 16 males) completed the questionnaires. Eleven participants reported that they adhered to a vegetarian diet and one participant a vegan diet. Moreover, eleven students said that they were following a special diet for weight loss (one of them was vegetarian).

2.2. Stimuli

The pictures were the same as those used by Prada et al. (2017) who themselves selected 210 images of food from "food-pics" (Blechert et al., 2014) (see pp. 17–18 for details about the selection of the pictures used by Prada et al., 2017). In the original Blechert et al. (2014) database, photographs of food have a resolution of 600 × 450 pixels, and are standardized on the dimensions of background color (white), viewing distance and figure-ground composition. In order to divide the food images of Prada's selection into four different homogeneous subsets, the 210 images were first sorted according to their category (e.g., fruit, cake, meat, fish, vegetables, fast food), and then, as far as possible, distributed in equal numbers to each subset. The non-food pictures were also taken from Blechert et al. (2014). The original set of pictures was randomly divided into four subsets comprising 52 or 53 food pictures and 24 or 25 non-food pictures. As the non-food item selection was more heterogeneous, the images were sorted, as far as possible, so that there were the same number of animals, kitchen utensils, etc. in each subset. When there were two or three images, but no more than four, of the same "object", we made sure that there were not two buckets, two clocks, etc. in the same set.

There were 32 participants per subset, except one in which there were 31 participants.

2.3. Procedure

After giving their informed consent, the participants had to judge the food-images on ten dimensions, namely arousal, valence, liking, familiarity, frequency of consumption, caloric content, healthiness, tastiness, desire to eat and level of transformation. The ratings for the pictures which were shown one at a time, were made using 10-point Likert scales. We used exactly the same instructions and scale anchors for the ten dimensions as Prada et al. (2017). (The non-food pictures were rated on only four dimensions: familiarity, arousal, valence and liking.) The pictures were randomly presented across participants. The order of the queries was randomized across trials between participants. The participants were instructed to rate the pictures spontaneously and were told that there were no right or wrong answers. The whole experimental session took about one hour to complete. The general procedure used in this study was approved by the Statutory Ethics Committee of the University Clermont Auvergne.

3. Results

The database used in the present study (in .xls format) is available in the Supplemental Material. The database also provides the mean ratings and their standard deviations for the ten collected variables for the food images and for the four variables collected for the non-food pictures.

3.1. Screening of the data

Four participants were set apart: Two participants were excluded because they reported being non-native speakers of French and the data of two other participants were discarded because they systematically used the same response for certain scales. Because of a technical problem, one picture (*pizza with salami,* image No 489 in the Blechert et al. [2014] database) was set apart. After taking account of these exclusions, each picture was evaluated by at least 30 participants.

3.2. Data analyses

Several analyses were performed on the data and are reported in the following order: (1) We describe the reliabilities that were computed for the different collected norms; (2) Individual differences concerning "state variables" (self-reported hunger, thirst and mood, BMI) and their relationships with participants' judgements on the normed dimensions are explored. Gender and diet effects are also described; (3) Descriptive statistics are reported as well as the distributions of the norms; (4) The bivariate correlations are provided and commented.

3.3. Reliability

The correlations between the by-items' means obtained from the even and odd participants and the intraclass correlation coefficients (two-way random effects, consistency, multiple raters/measurements conforming to the McGraw and Wong [1996] convention) computed within the picture subsets are reported in Table 1. With all coefficients being beyond 0.70, the consistency between the participants' ratings appeared to be high.

3.4. Individual differences

Concerning hunger, the participants' ratings were on average below the center of the scale (the midpoint of the scale was 5.5) ($M = 4.93$; $SD = 2.85$), 95% CI [4.43, 5.44], whereas the level of thirst was somewhat

Table 1
Correlations between the by-items means obtained from the even and odd participants and the intraclass correlation coefficients (two-way random effects, consistency, multiple raters/measurements using the McGraw and Wong (1996) Convention).

	R(even,odd)	ICC
Arousal	0.72	0.83 (0.80 - 0.87)
Valence	0.72	0.82 (0.76 - 0.87)
Liking	0.77	0.86 (0.80 - 0.90)
Familiarity	0.86	0.92 (0.89 - 0.94)
Consumption	0.81	0.90 (0.87 - 0.93)
Caloric content	0.98	0.99 (0.98 - 0.99)
Healthiness	0.97	0.98 (0.98 - 0.99)
Desire to eat	0.78	0.87 (0.83 - 0.90)
Tastiness	0.82	0.91 (0.90 - 0.92)
Level of transformation	0.96	0.99 (0.98 - 0.99)

Notes. For the ICC, first value = the mean of the ICCs computed internally for the four subsets of food items; in brackets = minimum and maximum of the ICC computed within subsets.

above the center of the scale ($M = 6.02$; $SD = 2.23$), 95% CI [5.63, 6.42]. This was also the case as far as mood is concerned ($M = 6.17$; $SD = 2.04$), 95% CI [5.81, 6.54][3].

The correlations between the average ratings given by the participants across images and the state variables were weak. Only the absolute values of the correlations between judgments of caloric content with hunger ($r = -0.25$, $p < .01$), and thirst ($r = -0.20$, $p < .05$), and between desire to eat and mood ($r = 0.21$, $p < .01$) were above 0.2. In addition, four other correlations were also significant: Tastiness and frequency of consumption were positively correlated with mood ($r = 0.20$ and $r = 0.19$, both $ps < 0.05$), as were desire to eat and valence with hunger ($r = 0.19$ and $r = 0.18$, $ps < 0.05$). No ratings were significantly correlated with BMI.

For all dimensions taken together, none of the differences between female and male participants were significant (all $ps > 0.156$). This finding is not surprising given the small number of men in our sample. However, it must be stressed that the differences turned out to be equally small when Cohen's d estimations were taken into account (see Table 2). Also, the participants who were following a specific diet to lose weight did not differ reliably from the remaining participants. Finally, no significant differences were observed between omnivorous and vegetarian (or vegan) participants. However, Cohen's d estimations suggest noticeable differences for certain dimensions: Valence ($p = .078$), arousal, desire to eat and tastiness (all $ps > 0.195$) were somewhat higher among the participants who were following a specific diet to lose weight, whereas the means corresponding to desire to eat ($p = .096$), tastiness and liking ($ps > 0.167$) were higher in omnivorous participants than in vegetarian or vegan participants.

3.5. Descriptive statistics

The distributions of the ratings on arousal, valence, and frequency of consumption were roughly symmetrical around their mean (see the descriptive statistics in Table 3 and the distributions in Fig. 1). We found the same characteristic as far as liking, familiarity, desire to eat and tastiness are concerned, but the ratings were more spread out, and more particularly for the latter two variables. Turning to the level of transformation variable, we observed two modes that were located at the beginning and at the end of the scale, respectively. Not surprisingly, items such as fruits and vegetables were generally judged as being less transformed than processed items, in particular sweets and ready meals (e.g., *cake*, *sandwich*).

Because of their close relationships with transformation level (see the correlations reported in Table 5), the properties of estimated caloric content and healthiness were approximately the same (with, however, less strong binary outcomes leading to ratings that were more uniformly distributed along the scales).

The average ratings were significantly beyond the center of the scale for liking ($p < .001$; 95% CI [6.37, 6.73]) and tastiness ($p < .001$; 95% CI [6.01, 6.41]), but less markedly so for valence ($p < .01$; 95% CI [5.55, 5.78]), healthiness ($p < .01$; 95% CI [5.67, 6.34]), and familiarity ($p < .05$; 95% CI [5.54, 5.91]). The opposite was found, however, for arousal ($p < .001$; 95% CI [3.51, 3.79]), frequency of consumption ($p < .001$; 95% CI [4.79, 5.16]), and perceived transformation level ($p < .01$; 95% CI [4.62, 5.34]). It is worth noting that these properties were also observed when only the participants with no diet restrictions were taken into account.

3.6. Differences in ratings: Type of food and category of food

We compared the different ratings following the dimensions put forward by Prada et al. (2017): caloric density (low versus high), degree of processing (whole versus processed), gustatory quality (sweet versus savory) and category of food (seven categories: beverages, cereals, sweets, fruits, vegetables, proteins and meals) (Given the low number of beverage exemplars (seven in total), we did not include them in the analyses.)

We ran independent t tests to compare the means on caloric density, degree of processing, and gustatory quality. A between-subjects ANOVA followed by post-hoc Tukey tests were run to compare the differences between the different food categories (Table 4).

With noticeable differences, the estimations of the caloric content of (objectively) low-caloric-density foods were lower than those of high-caloric-density foods. There were also large differences in the ratings of healthiness and transformation level, with objectively low-caloric foods being perceived as healthier and less transformed. Low-caloric foods were estimated to be less positive and arousing, tasty and liked, but more frequently consumed, than high-caloric foods (the differences were somewhat less noticeable than those found for healthiness and transformation level).

The differences between "whole" and "processed" foods pointed in the same direction as those found for low and high-caloric-density foods. They were, in particular, very large for perceived level of transformation, caloric content and healthiness, with the result that processed foods were rated as more transformed and as having a higher caloric density, but less healthy, than non-transformed foods. Processed foods were also estimated to be more arousing and tastier than whole food, although the differences were not very large. The somewhat small differences in valence, liking and frequency of consumption between low- and high-caloric density foods turned out to be not significant on the degree-of-processing dimension.

Savory foods were reliably perceived as being less arousing, positive, tasty, caloric and transformed than sweet foods. The former were also less desired and liked than the latter. By contrast, savory foods were perceived to be more familiar, frequently consumed and healthier than sweet foods.

Turning to the differences between the different categories of food (Fig. 2), these were reliable on all the collected dimensions, with the greatest differences being on healthiness, caloric content and transformation level . For these latter dimensions, the differences between the categories revealed by Tukey tests were nearly the same. Not surprisingly, among the different types of food, vegetables and fruits were rated as the least caloric and transformed as well as the healthiest. Just the opposite was found for sweets. Finally, the other types of food were

[3] It is worth noting that the participants were also asked to report the last time they had a full meal. However, and unfortunately, we did not ask them about when they had their last snack. Because certain participants completed the questionnaires in the morning, there is a great discrepancy/variability on this latter dimension. As a result, the estimations of the time that had elapsed since the last full meal were not very informative, and we therefore decided to discard these estimations from the analyses.

Table 2
Means (standard deviations) and Cohen's *d* according to gender and diets computed on the by-participants means.

	Means and standard deviations			Cohen's *d*		
	Total(N = 123)	Women(N = 107)	Men(N = 16)	Gender(W – M)	Weight diet(Yes - No)	Omnivorous - other diets
Arousal	3.65 (1.67)	3.69 (1.71)	3.41 (1.36)	0.17	0.43	-0.22
Valence	5.67 (0.93)	5.65 (0.98)	5.80 (0.61)	-0.16	0.59	0.24
Liking	6.55 (0.90)	6.55 (0.92)	6.58 (0.82)	-0.04	0.30	0.41
Familiarity	5.73 (1.04)	5.77 (1.04)	5.49 (1.09)	0.27	0.11	0.09
Consumption	4.98 (0.92)	4.99 (0.91)	4.90 (0.96)	0.11	-0.05	0.37
Caloric content	5.45 (0.73)	5.49 (0.70)	5.21 (0.88)	0.38	-0.30	-0.06
Healthiness	6.01 (0.60)	5.99 (0.55)	6.11 (0.84)	-0.21	-0.29	0.08
Desire to eat	5.45 (0.97)	5.43 (0.98)	5.56 (0.94)	-0.14	0.43	0.51
Tastiness	6.21 (0.91)	6.24 (0.89)	6.02 (1.01)	0.24	0.41	0.42
Level of transformation	4.98 (0.90)	4.98 (0.90)	5.00 (0.92)	-0.03	0.20	-0.19

Table 3
Descriptive statistics for the subjective norms.

	Mean	SD	Q1	Median	Q3	Skew	Kurtosis	Min	Max
Arousal	3.65	1.02	2.83	3.65	4.40	0.29	-0.46	1.53	6.81
Valence	5.66	0.85	5.06	5.65	6.35	0.07	-0.59	3.65	7.90
Liking	6.55	1.30	5.66	6.58	7.64	-0.27	-0.68	3.42	9.13
Familiarity	5.73	1.39	4.63	5.77	6.70	-0.09	-0.31	2.27	9.71
Consumption	4.98	1.37	4.00	5.00	5.93	0.20	-0.21	2.03	9.52
Caloric content	5.45	2.51	2.84	5.71	7.69	-0.08	-1.39	1.29	9.68
Healthiness	6.00	2.43	3.77	5.55	8.54	0.06	-1.44	1.80	9.87
Desire to eat	5.45	1.31	4.44	5.47	6.53	-0.09	-0.80	2.58	8.10
Tastiness	6.21	1.45	4.98	6.23	7.44	-0.18	-0.93	2.87	8.87
Level of transformation	4.98	2.65	1.82	5.84	7.38	-0.25	-1.60	1.13	9.06

Notes. SD = Standard deviation; Q1 = 25th percentile; Q3 = 75th percentile.

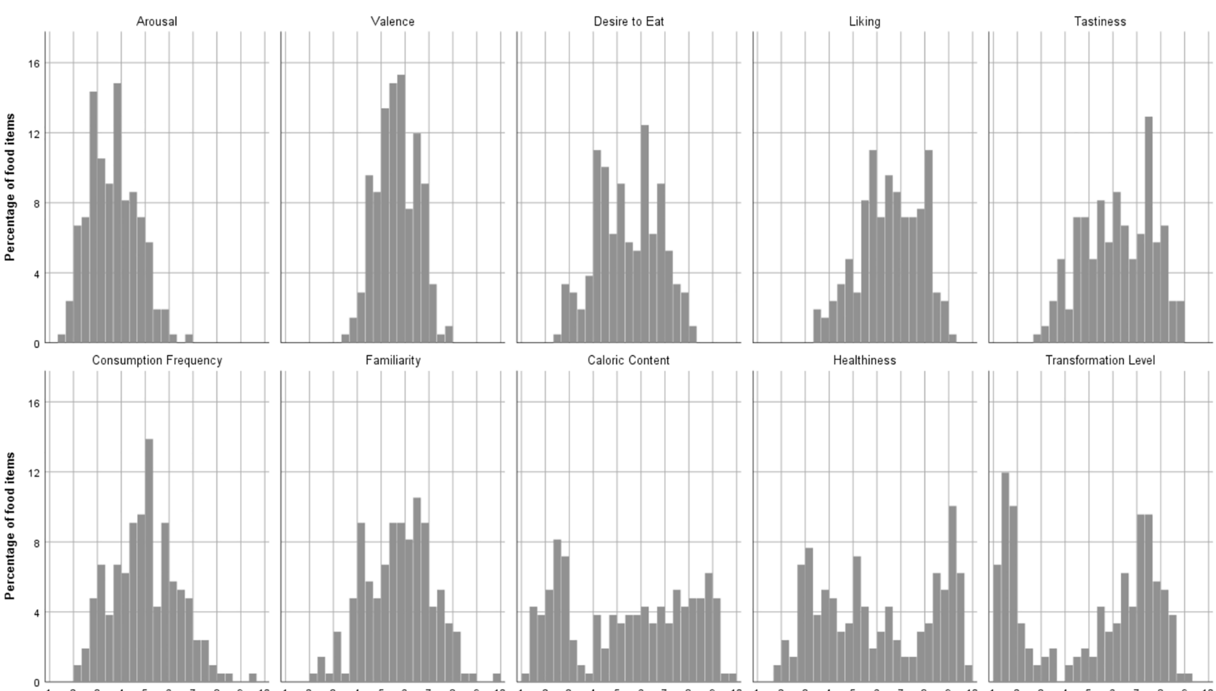

Fig. 1. Percentages of food items as a function of the different normed variables.

given ratings between those given for these two types of food, and the differences between them were less noticeable.

Turning to arousal, tastiness and valence, we found that vegetables were rated as the least arousing, tasty, and valenced (but the valence ratings were not significantly different from those for proteins). In contrast, sweets were judged as the most arousing, tasty and positively valenced. However, the differences between sweets, fruits and meals were not significant on these three dimensions. Finally, the ratings for proteins and cereals were intermediate between vegetables and sweets/fruits/meals.

Approximately, the same pattern of results, albeit with less strongly marked differences, was found with regard to liking and desire to eat. Finally, and surprisingly, sweets were perceived as the least familiar and frequently consumed type of food, but these ratings were not significantly different from the ratings given for vegetables. Moreover, the familiarity ratings given to sweets did not differ significantly from those

Table 4
Means (standard deviations) and Cohen's *d* according to caloric density, degree of processing and gustatory qualities computed on the by-images means.

	Caloric density			Degree of processing			Gustatory qualities		
	Low	High	*d*	Whole	Processed	*d*	Sweet	Savory	*d*
N	105	104		132	77		67	91	
Arousal	3.36	3.94	−0.58***	3.28	3.86	−0.59***	4.30	3.45	0.87***
	(1.00)	(0.97)		(0.98)	(0.99)		(0.94)	(0.99)	
Valence	5.50	5.83	−0.40**	5.54	5.74	−0.24	6.17	5.40	0.98***
	(0.92)	(0.73)		(0.90)	(0.81)		(0.75)	(0.81)	
Liking	6.36	6.74	−0.30*	6.40	6.64	−0.18	7.04	6.36	0.55***
	(1.43)	(1.13)		(1.38)	(1.25)		(1.25)	(1.22)	
Familiarity	5.83	5.62	0.15	5.79	5.69	0.07	5.39	5.88	−0.40*
	(1.45)	(1.32)		(1.50)	(1.32)		(1.33)	(1.17)	
Consumption	5.17	4.78	0.28*	5.16	4.87	0.22	4.67	5.15	−0.39*
	(1.44)	(1.27)		(1.48)	(1.30)		(1.30)	(1.13)	
Caloric content	3.68	7.24	−2.01***	2.88	6.95	−2.61***	6.57	5.43	0.47**
	(1.91)	(1.61)		(1.28)	(1.70)		(2.53)	(2.39)	
Healthiness	7.66	4.33	1.88***	8.42	4.60	2.41***	5.05	6.12	−0.45**
	(1.91)	(1.62)		(1.31)	(1.72)		(2.66)	(2.18)	
Desire to eat	5.28	5.61	−0.26	5.25	5.56	−0.24	5.85	5.34	0.41*
	(1.43)	(1.15)		(1.43)	(1.22)		(1.25)	(1.24)	
Tastiness	5.87	6.55	−0.48***	5.77	6.47	−0.50***	7.07	5.90	0.87***
	(1.60)	(1.20)		(1.58)	(1.31)		(1.14)	(1.47)	
Level of transformation	3.31	6.67	−1.64***	1.91	6.77	−3.99***	5.96	5.05	0.36*
	(2.26)	(1.80)		(0.86)	(1.38)		(2.84)	(2.32)	

Notes. *$p < .05$, **$p < .01$, ***$p < .001$

Table 5
Bivariate correlations between the measured variables.

	2	3	4	5	6	7	8	9	10
1. Arousal	0.88	0.86	0.79	0.80	0.30	0.34	0.36	0.45	-0.32
2. Valence		0.86	0.87	0.86	0.38	0.48	0.17*	0.25	*-0.10*
3. Tastiness			0.89	0.87	0.34	0.42	0.30	0.41	-0.23
4. Liking				0.95	0.59	0.68	*0.11*	0.23	*-0.05*
5. Desire to eat					0.67	0.75	0.12†	0.21**	*-0.02*
6. Familiarity						0.93	*-0.11*	*-0.10*	0.20**
7. Consumption							-0.19**	-0.17*	0.31
8. Level of transformation								0.90	-0.90
9. Caloric content									-0.94
10. Healthiness									1

Notes. Normal style: $p < .001$; ** = $p < .01$; * = $p < .05$; † = $p < .10$; Italic style: $p > .1$

given to fruits, and sweets and proteins were not judged to be differently consumed. The other types of food were perceived as homogeneous on these latter dimensions.

3.7. Correlations between dimensions

As can be seen from the correlations reported in Table 5, the variables can be grouped in three different subsets: (1) arousal, valence, tastiness, liking and desire to eat; (2) familiarity and frequency of consumption and (3) caloric content, level of transformation and healthiness. Within each group, the absolute values of the correlations were all above 0.79 and, with the exception of healthiness, the variables were positively correlated (for this latter variable, items high on healthiness were generally judged low on caloric content and as having lower level of transformation).

Concerning the relationships between the variables in the different subsets, frequency of consumption and familiarity were highly positively correlated with desire to eat and liking, and, although to a lesser extent, with valence, tastiness and arousal. In contrast, consumption and familiarity were only weakly related with the variables of the third subset (caloric content, level of transformation and healthiness), with the highest correlation here being between consumption and healthiness ($r = 0.31$). Noticeable correlations between the variables in the first and third subsets were also found: Caloric content and, to a lesser extent, estimated level of transformation were positively correlated with arousal and tastiness, with the result that more caloric and transformed items were rated as more arousing and tastier. Conversely, but to a lesser extent, healthier food items were judged as being less arousing and tasty.

Finally, the correlation between desire to eat and liking, on the one hand, and between familiarity and frequency of consumption, on the other, were very close (0.95 and 0.93 respectively). However, it is not possible to consider them to be strictly equivalent because of a few items that departed noticeably from the linear adjustment. (For example, if we take z-scores into account, *water bottle* turned out to be poorly liked compared to its desirability; *glass of red wine* and *expresso* were estimated to be less consumed than expected when their familiarity ratings are taken into account.)

4. Discussion

In the present study, norms were collected from adults for a subset of 209 food images used by Prada et al. (2017)—which were taken from the "food-pics" image database (Blechert et al., 2014)—on ten dimensions: arousal, valence, liking, familiarity, frequency of consumption, caloric content, healthiness, tastiness, desire to eat and level of transformation. Since there are no normative studies on food pictures available in French, unlike in the case of other types of stimuli such as pictures of objects (e.g., Alario & Ferrand, 1999; Bonin et al., 2003, 2020), the current work was designed to help overcome this shortage of stimuli. Importantly, we found that all the norms were reliable on the collected dimensions.

Thanks to the availability of standardized pictures of foods like those

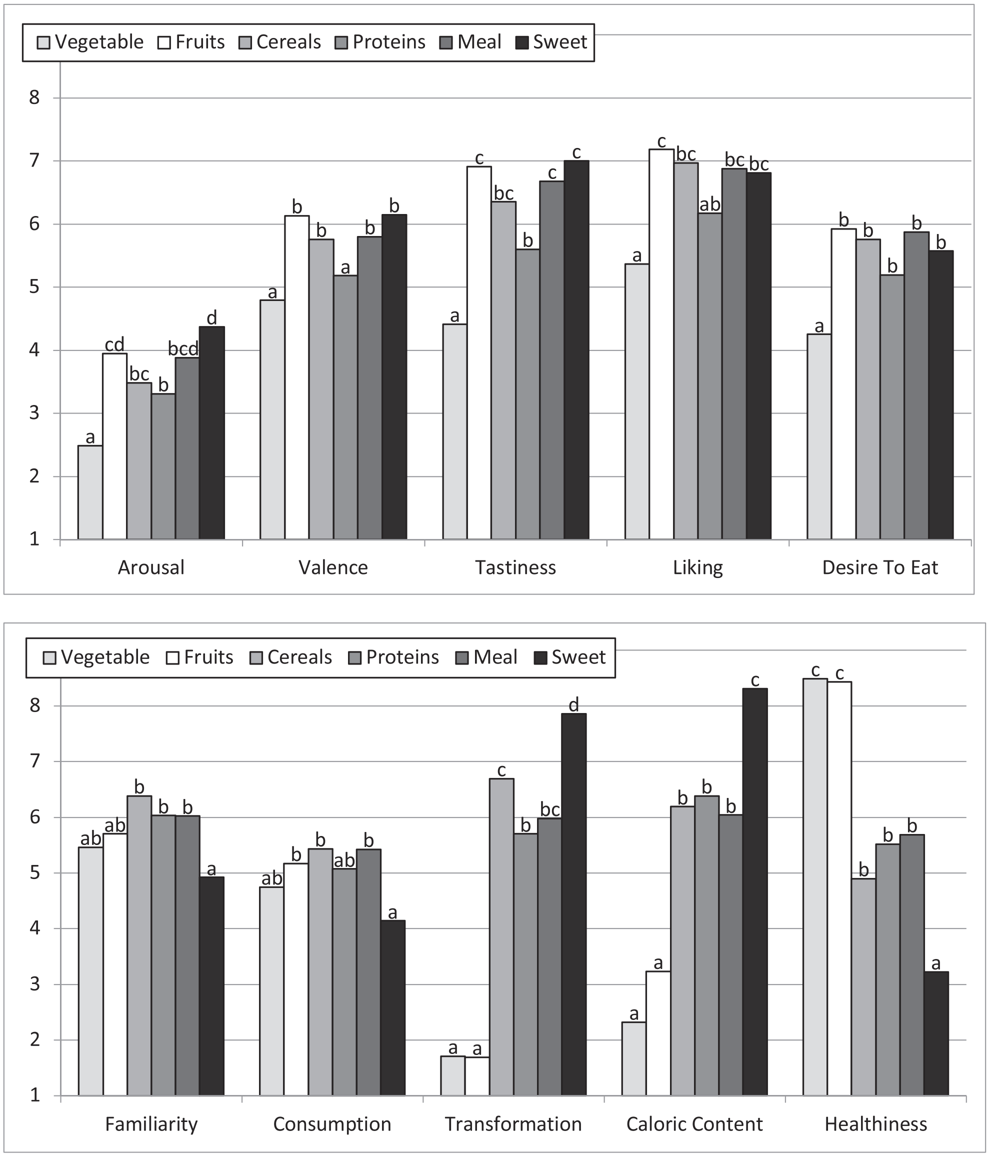

Fig. 2. Mean ratings for the different variables as a function of the category of food. (The letters on the bars indicate homogeneous groups after applying Tukey tests. Groups are ordered in alphabetic order, with "a" indicating the group with the lowest means. Other letters indicate the other homogeneous groups ordered by increasing levels of means.)

used in the current study, it will be possible to address a large number of issues pertaining to food processing. As reviewed in the Introduction, food-related behaviors can be investigated at both ultimate (e.g., food has helped our ancestors to survive and reproduce and this evolutionary pressure has sculpted several mechanisms dedicated to finding rich food-items) and proximate (e.g., how high versus low caloric food is processed in the brain) levels, both of which are interesting and complementary. More generally, our database should be useful for the investigation of eating behaviors in young and older adults, as well as in children and in teenagers.

From a general standpoint, normative studies on food pictures are useful because they permit the control—methodological or statistical—of the potential influence of confounding variables when investigating a specific variable in a given task involving the processsing of food from pictures. To illustrate, to test the hypothesis that transformed food (e.g., *pizza*) may be remembered better than natural food (*fruit/vegetables*) due to its higher caloric content which makes the former category of food extremely relevant for survival, researchers have to design experiments in which the memorization of (for example) pictures of the two types of food is compared, while at the same time controlling for other important dimensions pertaining to those stimuli. Indeed, such an experiment was recently designed by Aiello, Vignando, Foroni, Pergola, Rossi, Silveri, and Rumiati (2018). They selected pictures from the FRIDa database (Foroni et al., 2013), depicting natural and transformed food, and the two types of stimulus set were matched on valence and familiarity (among other variables). Interestingly, these authors were able to show that transformed food is remembered better than natural food.

Norms for food stimuli also help to establish the underlying structure of the norms. Likewise, in the present study, the correlational analyses showed that there were three subsets of variables that were closely and positively related (except healthiness) when evaluating food items, namely (1) arousal, valence, tastiness, liking and desire to eat; (2) familiarity and frequency of consumption and (3) caloric content, level of transformation and healthiness.

Finally, using a multiple regression approach, the availability of norms should permit the investigation in French participants of the relationships of the different variables with online (or offline) measures involved in food processing gathered, for example, by means of perceptual-attentional tasks (see, for examples: de Oca & Black, 2013; Kirsten, Seib-Pfeifer, Koppehele-Gossel, & Gibbons, 2019; Nummenmaa, Hietanen, Calvo, Hyönä, & Greenlee, 2011). Designing such studies should help better identify the determinants of eating behavior. This approach has often been used in the processing of objects such as object naming and it has made it possible to identify several important determinants of naming performance (e.g., Alario, Ferrand, Laganaro, New, Frauenfelder, & Segui, 2004; Bonin, Chalard, Méot, & Fayol, 2002; Bonin et al., 2003; Bonin, Guillemard-Tsaparina, & Méot, 2013; Bonin, Méot, Laroche, Bugaiska, & Perret, 2019).

Among our findings focusing on types of food and the collected dimensions pertaining to food are the observations that vegetables and fruits were estimated to be the least caloric and transformed as well as the healthiest, whereas the opposite was observed for sweets. The former type of food was also rated as the least arousing, tasty, and valenced and the latter as the most arousing, tasty and positively valenced. Although these findings might appear to be somewhat trivial, they nevertheless have to be empirically established.

As far as individual differences are concerned, we did not find that individuals following a specific weight-loss diet provided ratings that were reliably different from those who were not following a weight-loss diet. Also, there were no significant differences on the ratings given by omnivorous and vegetarian/vegan participants. However, these observations are only suggestive since they are based on a rather low number of participants. Thus, future studies involving more participants are warranted.

We acknowledge several limitations linked to the present normative study that may help frame the current findings and generate directions for future work. First of all, our participants tended to be relatively young, female-biased university students. As a result, how exactly different demographic variables may affect the ratings on the food pictures used here is an issue that remains to be investigated. For instance, it would be interesting to explore in future studies whether the pattern of findings reported here is found in seniors. Using food pictures, Padulo et al. (2017) have already found that elderly people have a preference for sweet food which is therefore not limited to children or adolescents. It would be possible to reframe the instructions in a way that permits the collection of norms on food pictures from children of different ages and teenagers. Likewise, it might be possible to investigate how food preferences change during the lifespan. In our normative study, there were more females than males, and it was therefore not possible to investigate sex differences in food evaluations in depth. It is generally thought that men have a greater preference for meat and a lesser preference for fruits and vegetables than women. Indeed, certain studies have shown that, unlike women, men prefer meat (Rozin et al., 2012), whereas the contrary is true for fruits and vegetables (Egolf et al., 2018; Padulo et al., 2017; Rozin et al., 2012). However, though interesting, such findings relating to sex differences are as yet scarce.

Another potential limitation of the current work is that the norms were collected from French-speaking adults who live in France, and the question of the extent to which our findings are comparable to those found in other countries and cultures remains to be thoroughly investigated. In the Results section, we did not report analyses comparing our findings with those of Prada et al. (2017) and Blechert et al. (2014) findings, which were collected in Portugual, Germany and United States, respectively, because it is possible that such a comparison between samples would be not valid, or informative due to potential confounds between samples. To name but a few such problems: the times of collection were different (Blechert's data were collected in 2013); the scales that were used were not the same, thus resulting in different anchor effects; the item rating contexts were also different (e.g., different number of images rated in each sample); the individual characteristics are different (e.g., age, sex, education, BMI). However, with these limitations (and potential weaknesses) in mind, we ran certain analyses to compare our findings with Prada et al.'s (2017) and Blechert et al.'s (2014) and these are available as Supplementary Material. Even though they certainly lack internal validity, and thus must be taken with caution, we think that they are nevertheless informative to some extent. In particular, an interesting aspect of note is that the differences between the categories of foods for caloric density and level of transformation as reported by Prada et al.(2017) were, for some ratings, highy variable between nations, and in some cases ran in opposite directions. Coupled with the observation that valence ratings were differently related to other ratings in the French and Portuguese samples, these results suggest that different processes, namely affective-behavorial and cognitive processes, could be differentially mobilized when estimating certain dimensions. In order to investigate these aspects in more depth and to have a more valid comparison between nationalities at our disposal, future work on culture differences in food evaluations should attempt, as far as possible, to use the same images, same ratings, same instructions and questionnaire tool, while also matching cultures/regions/countries on other between-person variables (age, sex, education).

In conclusion, we have provided norms in French adults for ten dimensions for 209 food pictures taken from the *food-pics* image database (Blechert et al., 2014) that we think will be useful to researchers who wish to investigate various issues pertaining to food-related behaviors.

CRediT authorship contribution statement

Patrick Bonin: Conceptualization, Methodology, Data curation, Writing - original draft, Writing - review & editing, Project administration, Supervision. **Helle Lukowski Duplessy:** Conceptualization, Methodology, Investigation, Data curation, Writing - review & editing. **Jean-Pierre Thibaut:** Conceptualization, Methodology, Writing - review & editing. **Alain Méot:** Conceptualization, Methodology, Data curation, Formal analysis, Writing - original draft, 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. Supplementary data

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