

Ferdenzi C, Delplanque S, Barbosa P, Court K, Guinard J, Guo T, Roberts SC, Schirmer A, Porcherot C, Cayeux I, Sander D & Grandjean D (2013) Affective semantic space of scents. Towards a universal scale to measure self-reported odor-related feelings, *Food Quality and Preference*, 30 (2), pp. 128-138.

This is the peer reviewed version of this article

NOTICE: this is the author's version of a work that was accepted for publication in Food Quality and Preference. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in Food Quality and Preference, [VOL 30, ISS 2 (2013)] DOI: <http://dx.doi.org/10.1016/j.foodqual.2013.04.010>

Affective semantic space of scents.

Towards a universal scale to measure self-reported odor-related feelings.

Camille Ferdenzi^{1,2}, Sylvain Delplanque^{1,2}, Plinio Barbosa³, Kimberly Court⁴, Jean-Xavier Guinard⁴, Taomei Guo⁵, S. Craig Roberts⁶, Annett Schirmer⁷, Christelle Porcherot⁸, Isabelle Cayeux⁸, David Sander^{1,2},
Didier Grandjean^{1,9}

¹ Swiss Center for Affective Sciences, University of Geneva, 7 rue des Batoirs, 1205 Geneva, Switzerland.

² Laboratory for the Study of Emotion Elicitation and Expression (E3 Lab), Department of Psychology, FPSE, University of Geneva, 40 Bld du Pont d'Arve, 1205 Geneva, Switzerland.

³ Department of Linguistics, State University of Campinas, Cidade Univeritária « Zeferino Vaz », Barão Geraldo, Campinas, São Paulo, Brazil.

⁴ Department of Food Science and Technology, University of California, Davis, 1 Shields Avenue, Davis, CA 95616, United States of America.

⁵ Key State Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing 100875, China.

⁶ Department of Psychology, University of Stirling, Stirling FK9 4LA, United Kingdom.

⁷ Department of Psychology, Faculty of Arts and Social Sciences, National University of Singapore, Lower Kent Ridge Road, Singapore, 119099.

⁸ Firmenich SA, route des Jeunes 1, P.O. Box 239, 1211 Geneva, Switzerland.

⁹ Neuroscience of Emotion and Affective Dynamics Laboratory (NEAD Lab), Department of Psychology, FPSE, University of Geneva, 40 Bld du Pont d'Arve, 1205 Geneva, Switzerland.

Correspondence to be sent to: Camille Ferdenzi, Swiss Center for Affective Sciences,

University of Geneva, 7 rue des Batoirs, 1205 Geneva, Switzerland. Email:

Camille.Ferdenzi@unige.ch or cferdenzi@hotmail.com. Tel: 00 41 22 379 98 10. Fax: 00 41

22 379 98 44

Abstract

1
2
3
4 Measuring self-reported affective feelings to odors and odorous products is a recent
5
6 challenge for the food and cosmetic field, requiring the development of suited instruments.
7
8 This paper finalizes a line of studies aimed at developing Emotion and Odor Scales (EOSs)
9
10 in several cultures. Previously available for Switzerland, the United Kingdom and Singapore,
11
12 new EOSs are presented here for the United States, Brazil, and China. These scales,
13
14 developed with 350 to 540 participants per country, have been conceived to allow the
15
16 measurement of affective feelings (e.g., emotions, moods, attitudes) in response to a wide
17
18 range of odors including pleasant and unpleasant, food and non-food ones. Several affective
19
20 categories were recurrent in the countries examined here: Disgust/Irritation, Happiness/Well-
21
22 being, Sensuality/Desire, Energy, but also Soothing/Peacefulness and Hunger/Thirst,
23
24 indicating a potential link between emotion and adaptive universal functions of olfaction such
25
26 as danger avoidance, ingestion and social communication. For these common categories,
27
28 similarity in affective responses generally reflected geographic proximity indicating also a
29
30 strong influence of cultural aspects. Exceptions to this pattern were Singapore and China,
31
32 with affective responses of Singaporeans being closer to those of Europeans. This series of
33
34 studies allows us to propose a universal scale (UniGEOS) that might be used in the future for
35
36 examination of other cultures. This scale comprises affective categories that we found to be
37
38 culturally shared, enclosing the most frequently shared affective terms, and several culture-
39
40 specific aspects that may be relevant in other cultures. This tool can be used in its complete
41
42 form (25 affective terms) or as a short version with 9 categories entitled Unpleasant Feelings,
43
44 Happiness/Delight, Sensuality/Desire, Energy, Soothing/Peacefulness, Hunger/Thirst,
45
46 Interest, Nostalgia and Spirituality.
47
48
49
50
51
52
53
54
55
56
57

Key-words

58 Olfaction, Emotion, Affective feelings, Self-report, Culture.
59
60
61
62
63
64
65

Introduction

1
2
3
4 The impact of olfaction on emotional processing is well known and can be
5
6 conceptualized as the result of low level of processing, shared with non-human animals, with
7
8 high adaptive functions such as the avoidance of spoiled food through the induction of
9
10 disgust feelings, and/or higher level of processing, involving complex cognitive mechanisms
11
12 influenced by inter-individual and cultural differences characterized by the sharing of values
13
14 and/or experiences among groups of people; nostalgia feelings are likely to be more
15
16 influenced by these latter aspects than disgust feelings, for example. In this study we would
17
18 like to propose a general model of the relationships between affective and olfactory
19
20 processing for the use of scientists and other people interested in the study of such
21
22 phenomena. Indeed, both fundamental and applied scientists might benefit from a general
23
24 model of self-reported odor-related affective feelings to start investigating the affective
25
26 phenomena induced by the processing of odors in different human groups and/or different
27
28 cultures.
29
30
31
32
33
34

35 Measuring affective responses to odors, and by extension to products for which odors
36
37 are a major characteristic (such as foods and cosmetics), is a recent challenge for the flavor
38
39 and fragrance industries. Initiated several decades ago (Kotler 1973), sensory -and thus
40
41 olfactory- marketing has undergone a major development (Rieunier 2002). This development
42
43 was sparked by an interest in favorably influencing consumer behaviors towards a product or
44
45 in a point of sale by stimulating the senses. Marketing studies showed that ambient scents
46
47 can positively impact product evaluations, time and (in some cases, not all: see Knasko
48
49 1989; Schifferstein & Blok 2002) money spent in consumption contexts such as stores,
50
51 restaurants or casinos (e.g., Hirsch 1995; Spangenberg et al. 1996; Morrin & Ratneshwar
52
53 2000; Guéguen & Petr 2006). Possible mechanisms could be that pleasant ambient odors
54
55 have a favorable impact on mood by activating positive associations stored in memory. This
56
57 may then produce approach behaviors and thus generally facilitate product orientation.
58
59
60
61
62
63
64
65

1
2 Alternatively odors may draw attention specifically to products they are congruent with (Seo
3 et al. 2010).
4
5

6 The human-product interactions are not only influenced by environmental odors, but
7 also by the olfactory properties of the product itself (among numerous other sensory,
8 functional or economic aspects). Odors associated with products may produce varied
9 emotional responses – from the most obvious ones such as liking/disliking to the subtlest
10 ones such as energizing (for a sport shower gel for instance). Numerous studies have shown
11 that odors influence mood (Knasko 1992, 1995; Schiffman et al. 1995a,b; Lehrner et al.
12 2005), performance in cognitive tasks as well as person and object evaluation (Rotton 1983)
13 congruently with their valence (see also Ehrlichman & Bastone 1992; Herz 2009). In addition,
14 behavioral and physiological approaches revealed that odors can alter an individual's arousal
15 by inducing relaxation or excitation (e.g., Torii et al. 1988; Bensafi et al. 2002a; Heuberger et
16 al. 2004; Goel et al. 2005). Although sensory affect is increasingly included in sensory testing
17 by the food and fragrance industry, and gains importance in product development, theoretical
18 and methodological supports are only in the early stages of development.
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

37 Methods used to measure self-reported affective feelings to odors have mostly been
38 inspired from the broader emotion literature and based on the valence-arousal (Russell
39 1980) or the basic emotion theories (Ekman 1984). Although valence is a dominant
40 dimension of odor perception (Engen 1982; Yeshurun & Sobel 2010), limiting the description
41 of emotional response to positive vs. negative (valence) and activating vs. calming (arousal)
42 feelings is perhaps oversimplified and not well suited for a comprehensive view of odor-
43 related affects. Just as inappropriate are basic emotions, usually defined as six states (*fear*,
44 *anger*, *sadness*, *surprise*, *joy* or *happiness*, and *disgust*) putatively characterized by specific
45 neural, physiological, expressive, and feeling components (Matsumoto & Ekman 2009).
46
47 Whereas *disgust* and *happiness* can clearly be elicited by odors, other basic emotions such
48 as *fear*, *anger* and *sadness* are much less often verbally reported (Alaoui-Ismaili et al. 1997;
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Bensafi et al. 2002b; Desmet 2006). This contrasts with verbal reports of emotions triggered by visual objects (Croy et al. 2011). Several recent studies have proposed more comprehensive questionnaires comprising either an extended set of basic emotions (22 terms: Desmet & Schifferstein 2008) or mood terms mostly taken from pre-existing mood scales (Churchill & Behan 2010; King & Meiselman 2010). However, even when the relevance of the affective terms was carefully controlled (King & Meiselman 2010), it must be conceded that these tools are highly product-specific (foods, and especially snacks: Desmet & Schifferstein 2008; King & Meiselman 2010; fragrances used in body care products: Churchill & Behan 2010) and may thus not be easily extended to other products or specific odorants. With the aim to tap a broader range of stimuli and affective facets, researchers from the University of Geneva initiated the development of the Emotion and Odor Scales, the characteristics of which are presented hereafter.

First, the Emotion and Odor Scales were designed to measure affective feelings in their widest sense (see Frijda & Scherer 2009). Accordingly, affective feeling is any emotional feeling that can be categorized as an emotion (e.g., happiness), an attitude (e.g., love), a personality trait (e.g., anxious) or a mood (e.g., cheerful) (Scherer 2005). The choice of terms relevant to describe odor-elicited feelings was solely based on participants' judgments of several hundred terms taken from the literature on emotion and odor perception. Second, the Emotion and Odor Scales were designed to judge feelings elicited by odors in general. Thus, the scale development process was based on participants' affective responses to a wide range of odor samples: pleasant and unpleasant, mostly familiar and pertaining to the food domain (sweet, savory, fruits, spices, drinks, and vegetables) or not (cosmetic, household, woody, plants, animal, floral, and medicine). Third, the participants involved in the development of the Emotion and Odor Scales were not only students, but also (and mostly) from the general population, which confers validity of the tools outside the laboratory conditions and for a broader audience. Additionally, the scales were developed based on examinations in different countries (first in Switzerland: Chrea et al. 2009; later in the United

1 Kingdom and Singapore: Ferdenzi et al. 2011; see also Ferdenzi et al. 2013) allowing the
2 identification of cultural invariants and making them suitable for examination in other
3 unstudied cultures. Fourth, the Emotion and Odor Scales have proven to be practical tools
4 during sensory testing either in their long (less than 40 items) or short version (6 items,
5 ScentMove® questionnaire: Porcherot et al. 2010, 2012, 2013). Fifth, some evidence was
6 brought that the Emotion and Odor Scales allowed a finer approach to affective feelings than
7 a simple valence measure (two samples with equivalent valence can be discriminated on
8 other affective aspects: Porcherot et al. 2010). Evidence of the superiority of this tool – in
9 terms of relevance, inter-rater agreement and discriminating power – compared to the
10 classical models of emotion (valence-arousal, and basic emotions) was also brought recently
11 in a dedicated study (Delplanque et al. 2012).
12
13
14
15
16
17
18
19
20
21
22
23
24
25

26 The first main aim of this article is to introduce the Emotion and Odor Scales developed
27 in four geographic areas that were not included in our previous studies: two in the United
28 States (Fayetteville, Arkansas, and Davis, California), one in an Asian country (Beijing,
29 China) and the latter in South America (Campinas, Brazil). Comparison of the scales
30 obtained in the different cultures presented here and in the previous publications (European
31 areas: Geneva, Switzerland, and Liverpool, United Kingdom; and another Asian country:
32 Singapore) are then performed in reference to geographic and historical differences. The
33 second main aim of this article is to propose, based on the different scales obtained in these
34 7 geographic areas, a unique scale that can be used in the future [in other cultures](#). As the
35 scale development procedure is demanding and thus cannot be repeated over and over, and
36 as there are substantial similarities between the different scales, we believe it makes sense
37 to propose such a global scale for future research in olfaction and emotion.
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Method

Participants

Age, gender and smoking habits of the participants as well as sample sizes are provided in Table 1 for the seven geographic areas. The participants in Studies 1 and 2 were recruited among university students and the participants in Study 3 were recruited among the general public during public events (Geneva, Davis), in public places such as museums (Liverpool, Singapore, Beijing), libraries (Davis, Campinas), parks (Beijing) or among a [database of people from the general population](#) (Fayetteville). Only participants who had spent most of their life in the countries where the experiment took place were included in the study (or in one of the adjacent countries with the same language, e.g., France for the Swiss sample, Ireland for the British sample, etc.). Informed written consent was obtained prior to participation. Committees on Research Ethics of all the Universities collaborating on the project approved the studies.

Materials

Affective terms

The final Emotion and Odor Scales are the result of affective term selection from an initial set of about 480 terms. These terms were taken from the literature with or without reference to the olfactory modality. They were chosen to refer to affective feelings experienced in everyday life and to cover a wide range of emotions, moods, personality traits and attitudes. The experiment was performed in French in Geneva, Chinese in Beijing, Portuguese in Campinas, and English in the other places. Therefore, independent French, Chinese and Portuguese native speakers followed a strict procedure to translate the initial set of English terms into the target language. Specifically, a first person translated the English terms into the target language, and two or three other independent individuals translated this target list back into English without knowledge of the initial English list. The coordinating experimenter (CF) then checked the correspondence between the initial list and the back-translated list,

1
2 and new attempts of translation were made when necessary (for 15% of the terms in Brazil
3 and 18% in China) after clarifying the meaning of the initial term.
4
5

6 Scale construction

7
8 Three selection steps or studies were used to obtain the final scales from the initial list of
9 affective terms. These three steps are presented in detail in Chrea et al. (2009) and Ferdenzi
10 et al. (2011), and are summarized hereafter. In Study 1, participants evaluated each initial
11 term on a continuous scale for its ability to describe affective states elicited by odors,
12 referring to their own past experience. No odors were smelled during this initial step. Only the
13 most relevant and well-understood terms were kept, i.e. about 70-80 terms. In Study 2 and 3,
14 participants were provided with odor samples (14 odor samples from a total of 24 in Study 2,
15 and 7-8 odor samples from a total of 56 to 59 in Study 3) and for each odor they were asked
16 to rate the intensity of their affective feelings using the terms selected in the previous study.
17 An Exploratory Factor Analysis with Varimax rotation was performed on the data of Study 2
18 (Statistica). It allowed us to identify dimensions having satisfactory internal consistency
19 (Cronbach's alpha $>.70$; Kline 1993) and to subsequently retain terms that had both high
20 loading on these dimensions and high inter-rater agreement, i.e., between 30 and 40 terms
21 in total. The aim of Study 3 was to test the robustness of the scale structure with a wider set
22 of odorants and a larger sample of participants from the general public. A Confirmatory
23 Factor Analysis (MPlus; Muthén & Muthén 2010) allowed us to test several structures
24 (obtained from Exploratory Factor Analysis performed on the data from Study 2 and 3, as
25 such and sometimes modified according to structures previously obtained in other
26 geographic areas). We finally retained as the final Emotion and Odor Scale the structure or
27 model with the best fit in each geographic area, i.e., with the lowest Root Mean Square Error
28 of Approximation and the highest Comparative Fit Index (RMSEA being $< .06$ and CFI $> .90$,
29 according to recommendations for the definition of a good model; Hu & Bentler, 1999).
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Odors

1
2 Most odorous stimuli used in Study 2 and 3 were identical in all geographic areas and
3 represented a large range of everyday odors including: i) as many pleasant as unpleasant
4 odors, ii) a high proportion of familiar odors to elicit affective reactions linked to
5 autobiographical memories (including culture-specific odors, such as durian in Singapore), iii)
6 odors related to various food and non-food contexts. The list of 24 odors of Study 2 and 56
7 odors of Study 3 can be found in Chrea et al. (2009). In Study 3, several culture-specific
8 odors were added to the 56-odor set: coconut, passion fruit, and banana in Brazil; soybean,
9 coconut, and pandan in Singapore; soybean, and tea in China. This was performed to keep
10 the odor set at an overall satisfactory level of familiarity in these cultures, not to miss any
11 important but culture-dependent odor-elicited responses, and thus to favor the elicitation of
12 affective feelings as they occur in everyday contexts. The odorous substances, provided by
13 Firmenich SA, Geneva, were diluted in odorless dipropylene glycol to obtain similar
14 subjective intensities (see Delplanque et al. 2008; Chrea et al. 2009). Pen-like devices
15 (Sniffin' Sticks, Burghart GmbH, Germany) were filled with 7 ml of each diluted solution and
16 coded with a 3-digit number. To limit olfactory fatigue and test duration, each participant
17 evaluated a sub-set of fourteen odors in Study 2, and seven or eight odors in Study 3. During
18 data collection, the odors were presented in random order.

Procedure

41
42 Sessions in Study 1, 2 and 3 took respectively 1 hour, 1.5 hours and 20 minutes.
43
44 Participants were asked to rate the intensity of their feelings with the help of the proposed
45 affective terms. They were presented with the affective terms on a computer interface and
46 gave their answers using a visual analogue scale labeled from “not at all” to “extremely”.
47
48 Their ratings were subsequently translated into a 0 to 200 score. When odors were
49 presented (Study 2 and 3), affective ratings were followed by familiarity, pleasantness and
50 intensity ratings on similar scales. Free odor identification was collected as well, except in
51 Geneva, the first culture that was investigated, where this measure was unfortunately omitted

1 because this question was not addressed at that time. More details about the procedure can
2 be found in Chrea et al. (2009) and Ferdenzi et al. (2011). The studies were conducted by C.
3 Chrea and collaborators in Geneva, by C. Ferdenzi (CF) and collaborators in Liverpool, and
4 by on-site collaborators in the other geographic areas (coordinated by CF).
5
6
7
8
9

10 **Results**

11 *Presentation of the final scales*

12
13
14
15
16
17 Results from Study 3 are reported here. Table 2 presents the goodness of fit results of
18 the best model obtained for each geographic area with the Confirmatory Factor Analysis. All
19 models have a good fit (RMSEA < .06 and CFI > .90). Each model (or scale, with terms
20 organized in several latent variables that we will call affective categories from now on) is
21 detailed in Tables 3a,b. The label of the categories was the result of subjective
22 interpretations of the overall affective meaning of the group of terms gathered in these
23 categories. Internal consistency of each affective category and of each term has been
24 computed with Matlab (Cronbach's alpha), and is mentioned in Tables 3a,b, together with the
25 parameter estimates of the terms.
26
27
28
29
30
31
32
33
34
35
36

37
38 Examination of the structure of the scales reveals that there are numerous affective
39 categories that can be interpreted/labeled similarly in all studied geographic areas, even if
40 these categories are not constituted by strictly identical lists of terms. Indeed, there are
41 groups of affective terms related to Disgust/Irritation, Happiness/Well-being,
42 Sensuality/Desire and Energy in the seven geographic areas. Soothing/Peacefulness and
43 Hunger/Thirst were revealed by the factor analyses in respectively five and four geographic
44 areas, and Negative Feelings and Nostalgia in two geographic areas. Finally, several
45 categories were culture-specific and they are found mostly in Asian countries (except
46 Sensory Pleasure in Geneva): Arousal and Melancholy in Beijing, and Intellectual Stimulation
47 and Spirituality in Singapore (see terms in Tables 3a,b). Inter-rater agreement was very good
48 for most categories (Cronbach's alpha >.70; only Arousal in China and Spirituality and
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1 Negative Feelings in Singapore were between .60 and .70). At the term level, inter-rater
2 agreement was very good on average (from .75 in Singapore to .94 in Fayetteville).
3
4 Questionnaires, including instructions and terms of the EOS are available at the following
5
6 Internet address: <http://www.affective-sciences.org/eos>.
7
8
9

10 *Cultural differences in affective feelings*

11
12 To investigate and visualize the extent of cultural differences and similarities, we
13 combined Cluster and Multi-Dimensional Scaling (MDS) analyses. First, cluster analyses
14 (Ward's method on city-block –Manhattan– distances¹) were performed for each affective
15 category common to four or more geographic areas (i.e. Disgust/Irritation, Happiness/Well-
16 being, Sensuality/Desire, Energy, Soothing/ Peacefulness and Hunger/Thirst), using the
17 average scores per odor per geographic area (56x7 matrices). These analyses provided a
18 matrix of the distances between the geographic areas for each affective category, and
19 allowed us to constitute groups of areas as a function of their statistical proximity.
20
21 Determination of the number of groups (i.e., clusters), generally two or three, was based on a
22 visual determination of the inflexion point on the plot of linkage distances. For graphic
23 representation purposes, we then conducted MDS on each distance matrix and found that
24 two-dimensional spaces were the most suited (increasing the number of dimensions did not
25 improve the part of explained variance, i.e., did not decrease the stress values). Figure 1
26 illustrates the MDS results on two-dimensional spaces and the groups obtained with the
27 cluster analyses. The results suggest that, except for the Asian countries, geographic
28 proximity is linked to a similarity in odor-related affective feelings and odor perception.
29
30 Namely, the two regions of the United States, Arkansas and California, are always in the
31 same cluster (EOS categories but also familiarity, liking and identification), and Brazil is
32 rather close to them as it is in the same cluster for most olfactory variables. Similarly, the two
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55

56 ¹ City-block (Manhattan) distance is the average difference across dimensions. In most cases, this distance
57 measure yields results similar to the simple Euclidean distance. However, in this measure, the effect of single
58 large differences (outliers) is dampened since they are not squared. Ward's method uses an analysis of variance
59 approach to evaluate the distances between clusters. It attempts to minimize the sum of squares of any two
60 (hypothetical) clusters that can be formed at each step. In general, this method is regarded as very efficient (see
61 *Electronic Statistics Textbook* for further details; StatSoft, Inc., 2013; <http://www.statsoft.com/textbook>).
62
63
64
65

1 European countries, United Kingdom and Switzerland, appear in the same cluster for all the
2 EOS categories they are concerned with, and for liking. However, China seems to be quite
3 different from the other geographic areas, since this area alone constitutes a separate cluster
4 in three EOS categories out of five. Also, it is always fairly distant from the other Asian
5 country, Singapore, which tends to be closer to the European countries (clustered with them
6 for all the EOS categories).

7
8
9
10
11
12
13 Based on the same 56 odors x 7 countries matrices, we conducted repeated-measures
14 ANOVAs to investigate cultural differences in scale use (only the six categories available for
15 all the seven countries were taken into account: Disgust/Irritation, Happiness/Well-being,
16 Sensuality/Desire, Energy, Familiarity, and Liking). There was a significant effect of country
17 on the average ratings ($F_{6,330} = 216.99, p < .001$), which can be described as: Singapore <
18 United Kingdom < Switzerland < United States, China and Brazil (based on post-hoc Tukey
19 HSD tests). There were also significant effects of category and a country by category
20 interaction, but we decided not to present them here because they do not add valuable new
21 elements to further qualify country differences.

22 23 24 25 26 27 28 29 30 31 32 33 34 35 *Construction of the universal scale UniGEOS*

36
37 Emotion and Odor Scales have now been developed specifically for geographic areas
38 with very distinct cultures on different continents (Europe, America and Asia). We previously
39 proposed (Ferdenzi et al. 2011; Delplanque et al. 2012) that the affective categories common
40 to the different scales we developed and confirmed by the new scales presented in this
41 article might be related to major functions of olfaction in humans, such as ingestion,
42 avoidance of environmental hazards, and social communication (Stevenson 2010). Affective
43 responses such as disgust, desire, or well-being certainly play a major role in driving
44 subsequent behaviors related to functions of olfaction that are common to all human beings.
45 Therefore, we now would like to propose a new scale, mainly based on the culturally
46 common affective categories we found, which would be likely to tackle affective feelings
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1 triggered by smell in humans in general and thus potentially in most new cultures
2 investigated with this scale.
3

4 To define this scale we used three criteria. First, term selection was based on the
5 number of occurrences of the terms in the cultures we have already studied. The most
6 frequently used terms were prioritized to increase the likelihood of the terms being relevant in
7 additional cultures. Second, a maximum of three terms per category were chosen, to allow
8 the use of the scale in its short or long version, the short version consisting of an evaluation
9 of the three items in the category as a whole on a unique subscale (see Porcherot et al.
10 2010), and the long version evaluating each term. Third, the retained categories were
11 prioritized as those that were common to four or more of the seven studied geographic
12 areas. This approach yielded six categories that are detailed below. We decided to add three
13 categories derived from culture-specific aspects, with the aim to cover the largest possible
14 spectrum of odor-related affective feelings while respecting the overarching goal of creating a
15 compact scale.
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

31 Consequently, six categories common to four or more geographic areas were first
32 retained: Disgust/Irritation, Happiness/Well-being, Sensuality/Desire, Energy,
33 Soothing/Peacefulness, and Hunger/Thirst. Their labels were in some cases slightly modified
34 to avoid redundancy between the category title and its constituting terms (e.g., the category
35 Disgust/Irritation and the term disgust), as shown in Table 4. The number of occurrences of
36 each term (i.e., number of scales among the seven available in which the term appears) is
37 mentioned in Table 4. The three additional categories cover aspects related to interest,
38 nostalgia and spiritual feeling. For the Interest category we gathered three terms, taken from
39 the Sensory Pleasure (CH), Arousal (CN) and Intellectual Stimulation (SG) culture-specific
40 categories (Tables 3a,b), that are related to the holding or the attraction of one's attention in
41 a very pleasant (amusement) or rather positive way (interesting, impressed). For the
42 Nostalgia category, we gathered the term nostalgic from the Nostalgia category (UK & BR)
43 and the terms melancholic and sad present in the Melancholy (CN) and the Negative Feeling
44 category (SG). It must be kept in mind, however, that nostalgia, although being close to the
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1 feelings of sorrow or regret, is likely to be slightly more positive than sad and melancholic
2 states because it refers to the yearning for the return of past pleasant circumstances. Finally
3 we added Spiritual Feelings (SG) because we thought that despite its cultural specificity it
4 might be meaningful in other cultures with strong odor-related rituals such as religious or
5 other ones.
6
7
8
9

10 11 12 **Discussion** 13 14 15 16

17 The present research allowed to complete the set of affective scales that was initiated
18 a few years ago (EOS, Emotion and Odor Scales: Chrea et al. 2009; Ferdenzi et al. 2011) by
19 adding new Asian and American cultures, and by then proposing a single universal scale
20 (UniGEOS) for the future study of odor-related affective feelings [in other cultures](#). The
21 preliminary result that some categories of feelings are recurrent in different cultures was
22 confirmed. Namely, the categories Disgust/Irritation, Happiness/Well-being,
23 Sensuality/Desire and Energy were found in the seven studied geographic areas, and
24 Soothing/Peacefulness and Hunger/Thirst in almost all of them – which also justifies the fact
25 that they were kept in the UniGEOS.
26
27
28
29
30
31
32
33
34
35
36

37 The main theoretical implication of this line of studies is that self-reported feelings in
38 response to odors are more accurately depicted using an olfactory-specific set of emotional
39 terms (Chrea et al., 2009; Ferdenzi et al. 2011; Delplanque et al. 2012). Indeed, the
40 emotional categories introduced in our studies and observed in many different cultures
41 extend traditional basic emotions or valence-arousal-dominance approaches applied to
42 olfaction. We have proposed that, on the one hand, by focusing on a small number of
43 evolutionarily based basic emotions, one downplays the more complex forms of emotional
44 processes involved in response to odors. On the other hand, with a description limited to two
45 or three dimensions as for the valence-arousal-dominance approach, one misses most of the
46 important qualitative differences between the affective effects of different types of odorous
47 substances (Delplanque et al. 2012). This result does not constitute an epiphenomenon
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1 associated with a specific culture since common emotional categories were found across the
2 cultures we studied.

3
4 The present results also reinforce the idea, proposed previously, that the identified
5 categories of affective responses to odors are common to different cultures because they
6 contribute to the major functions of olfaction in humans. Emotional, and more generally
7 affective processes are viewed as adaptive mechanisms that allow the individual to adjust to
8 environmental conditions or events by displaying adapted, suited behaviors (Scherer 1994;
9 Keltner & Gross 1999). In this frame, the feeling component of an emotion integrates and
10 might regulate its other components (cognitive, behavioral, expressive, and physiological) to
11 motivate a response that fits the demands of the physical and social environment (Grandjean
12 et al. 2008; Scherer 2009). Specifically, subjective affective experiences of odors may serve
13 universal and phylogenetically grounded functions of olfaction in humans, which have been
14 classified into three major categories by Stevenson (2010). First, some odor-related affective
15 feelings, such as disgust for stimuli representing a source of disease or fear of stimuli
16 announcing a danger, (e.g., a fire or a gas leak), serve the first function: avoidance of
17 environmental hazards. The second function of olfaction is ingestion including the “detection
18 and identification of food suitable for eating, rejection of foods that have an unexpected
19 flavor, modulation of appetite, and promoting breast feeding in neonates”. Several odor-
20 related affective feelings can serve this function. The feelings of hunger and thirst prompted
21 by food odors (Hunger/Thirst category) are directly involved in appetite stimulation,
22 promotion of food/beverage intake and result from the identified suitability of the
23 corresponding product for eating. In addition, feelings of Disgust/Irritation may promote
24 withdrawal behavior when expectations are broken by foods with an unexpected flavor (e.g.,
25 spoiled). Feelings of Happiness/Well-being could reflect some feelings associated with the
26 satisfaction produced by food intake. The third function of olfaction described by Stevenson
27 (2010) is social communication, namely “human mate selection in respect of inbreeding
28 avoidance and fitness detection, and emotional contagion”. In this perspective, affective
29 feelings related to Sensuality/Desire are a preliminary step to potential approach of other
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1 individuals, partly guided by the blend of natural body odor and extraneous (e.g., cosmetic)
2 fragrances emitted by these individuals: body odors are indeed known to help guiding bias
3 against inbreeding (Weisfeld et al. 2003, but see also Ferdenzi et al. 2010) and to promote
4 genetic diversity (e.g., Wedekind et al. 1995), cosmetic odors being potentially consistent
5 with the latter signal (Milinski & Wedekind 2001; Lenochová et al. 2012). Extraneous odors
6 may have their importance in the EOS category, since those contributing the most to form
7 this category are related to cosmetics (namely flowery and fruity odors). Finally, Energy and
8 Soothing/Peacefulness could depict feelings that motivate responses in relation to many
9 functions of olfaction and could be, for instance encountered in food or social contexts
10 (stimulation by a food odor initiating eating behavior, or by the exciting smell of a potential
11 partner, comfort provided by food ingestion or by smelling the partner's odor). Less vital
12 along phylogeny, and maybe becoming relevant specifically in humans, they could be
13 associated with a 'comfort' function: wellness, a state related to physical integrity (health) and
14 psychological fulfillment of expectancies. An example of this is ancient as well as
15 contemporary aromatherapy (see Herz 2009), which uses plant-based aromas to promote
16 well-being, and stimulation or relaxation depending on the needs.

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

There are cultural differences though in the way these common affective categories are used in response to the different odors we specifically used in our study (beyond the differences in the way to use scales in general, as described in the Results section). Before discussing these differences, we would like to emphasize the particular care we took to limit as much as possible variations that could be attributed to pure experimental differences across cultures. This was achieved by a rigorous coordination work consisting in providing each experimenter with the same stimuli, the same test interfaces and the same detailed instructions on how to conduct the study and recruit participants. Although such undesired variations cannot totally be ruled out, we believe that the observed variations are most likely due to cultural differences than to experimental biases, and they will be discussed as such. Looking at the results, we found that there were more similarities between areas with higher

1 geographic proximity, a result similar to the conclusions of the study on aroma preferences
2 conducted by Pangborn et al. (1988) on the five continents. The two regions of the United
3 States, Arkansas and California, have extremely similar affective answers to the presented
4 odors, and Brazil, another American culture, is often classified in the same group. Although
5 being culturally very different, it is thus likely that there are more similarities between Brazil
6 and the United States than between the United States and Europe, both in terms of quality of
7 the olfactory environment, contexts in which given odors are encountered and food/cosmetic
8 habits associated with given odors. A similar conclusion can be made for the European
9 countries, United Kingdom and Switzerland, that were found to have similar affective
10 responses and that differentiated quite well from the American countries. The results
11 concerning the two Asian countries Singapore and China have to be interpreted differently.
12 China appears to behave, in terms of odor-related affective feelings, in a rather unique way
13 compared to all other countries, including Singapore, especially for Happiness/Well-Being,
14 Sensuality/Desire and Soothing/Peacefulness. As it does not seem to be driven by major
15 odor familiarity or pleasantness differences (see Fig. 1), it is likely to be due to differences in
16 emotional functioning between Eastern versus Western countries (e.g., related to
17 interpersonal styles, independent or individualistic in Western cultures versus interdependent
18 or collectivist in Eastern cultures, Markus & Kitayama 1991; higher sensitivity to social
19 desirability in Eastern cultures; Middleton & Jones 2000; stronger self-regulation of negative
20 emotions in Eastern cultures: Markus & Kitayama 1991). Singapore's affective responses to
21 odors were found to be close to European responses – in spite of significant differences in
22 familiarity, pleasantness and identification. This is surprising on the one hand, since many
23 Singaporeans originate from China (79% of our participants were of Chinese ethnicity, see
24 Ferdenzi et al. 2011). But on the other hand, the almost two centuries of British colonization
25 (19th and part of 20th centuries, during which Chinese population increased in Singapore) and
26 the massive industrialization of the country at the end of the 20th century are likely to have
27 strongly influenced thinking and behaviors in a Western-like way.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

The cultures we investigated also differed on several culture-specific feeling categories. Some of them are clearly or slightly negatively connoted (Negative Feelings in California and Singapore, Melancholy in China), while some are related to nostalgia (in the UK, Brazil and Switzerland), interest elicitation (Arousal in China, Intellectual Stimulation in Singapore, and partly in the Sensory Pleasure category in Switzerland) and spirituality (in Singapore). Although it remains difficult to explain why some categories are present in some cultures and not in others, we can formulate some speculations. For instance, odors (incense) are very frequently associated with religious rituals in the Singaporean Chinese community (Friborg et al. 2008; Ferdenzi et al. 2011) explaining the importance of the affective feelings related to Spirituality in this culture. In Brazil specifically, the term “saudoso” was added to the list of initial terms: in every country we studied, on-site collaborators were given the possibility to suggest some additions to the list of initial terms if they felt that an affective feeling important to their culture was missing (it was effectively the case only in Brazil). “Saudoso” was added because it is considered a very important feeling in this culture (so much that it is celebrated on a dedicated day of the year), although very difficult to translate in other languages (sort of nostalgia imbued with melancholy). It explains why Nostalgia is a significant category kept along the Brazilian scale construction.

40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

The above-discussed cultural similarities, as well as some cultural specificities, have been summarized in the universal scale UniGEOS proposed in this study, and for which we can now provide several recommendations of use. First, we would like to emphasize that it is always better to use the culture-specific model if available instead of the universal version, because it more closely fits the feelings experienced in that culture (Ferdenzi et al. 2011). Second, UniGEOS can be used in different ways according to the testing constraints. According to time constraints it can be used either in its long or short form. The 25 affective terms of UniGEOS can be rated individually, possibly in a random order (but we recommend similar order for the different odors judged by a given rater, to limit cognitive load), or only 9 series of 3 (or 1) terms corresponding to the 9 categories of UniGEOS, similarly to Porcherot

1 et al. (2010) with the Swiss version. We can presume that, as in Porcherot et al. (2010),
2 responses to both versions should be highly correlated. In addition, although we always used
3 continuous rating scales with labels on each end for a finer discrimination between odors
4 during the processes of scale development, other methods might be preferred such as a
5 discrete rating scale (1-to-9 for instance, same labels) or even the check-all-that-apply
6 method (CATA) for which respondents only indicate whether each feeling is experienced or
7 not. Finally, it must be kept in mind that categories 1 to 6 (see Table 4) are very likely to be
8 relevant for most studied cultures, whereas categories 7 to 9 may or may not be relevant
9 since they were derived from several culture-specific categories. If ever a category is not
10 relevant, i.e., if an affective feeling is never experienced, it has no further consequences than
11 getting scores close to zero. Moreover, users must be warned that the terms we artificially
12 put together in categories 7 to 9 are likely to be less correlated within a category than the
13 terms in categories 1 to 6. Indeed, in categories 1 to 6, factor analyses objectively revealed
14 their relationship, whereas in categories 7 to 9, terms were gathered based on a more
15 subjective similarity (see procedure in Construction of the universal scale UniGEOS).
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

35 Despite the significant theoretical and practical advantages of the Emotion and Odor
36 Scales detailed in the introduction, some limits of these tools should be acknowledged. First,
37 when using the EOSs, one should keep in mind that the terms only capture one of the
38 emotional components, namely feelings, not the full emotional phenomenon. Although the
39 feeling component of an emotion is supposed to integrate and regulate the other components
40 (i.e., action tendencies, physiological arousal, cognitive processes, and expressive motor
41 behavior, e.g. Frijda & Scherer 2009), we can only assert that the EOSs capture “potential
42 emotions”. The current differentiation on the feeling level needs to be confirmed by
43 differentiation on a cognitive, behavioral, or physiological level to be fully considered as true
44 emotions (Zentner et al. 2008).
45
46
47
48
49
50
51
52
53
54
55
56

57 Second, whereas other similar scales were developed recently with specific categories
58 of products (snacks: Desmet & Schifferstein 2008; King & Meiselman 2010; body care
59
60
61
62
63
64
65

1 products: Churchill & Behan 2010), our scales have been conceived to measure affective
2 responses to a wide range of odors, not only pleasant ones, and not from only one category.
3
4 Of course this is an advantage because we presume it can be used for varied odor-emitting
5 products (foods, cosmetics but also other consumer goods such a car interiors, or places
6 such as stores or underground parking). But it must be acknowledged that using the EOSs
7 for a given category of odorous products (e.g., shampoos, air care or food products) would
8 reduce its power to discriminate between different feelings. Indeed, as developed above,
9 each affective category could be more or less associated with a function of olfaction. When
10 using a specific range of products, it is very likely that only one type of function would be
11 targeted, thus automatically weakening the discriminative power of the EOSs, which may
12 also miss affective aspects related to that specific category of products. Indeed, EOSs do not
13 allow measuring the affective response to the whole product (which involves many other
14 aspects such as sensory and esthetic, practical and economic aspects). Future research
15 should test the adequacy of the EOSs to do so, or investigate to what extent modified
16 versions of the EOSs with additional specific subscales might be useful.
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

32
33 Third, it must also be acknowledged that, even if the EOSs are specifically targeted at
34 odors, an odor is hardly dissociable from its source, as is clearly shown by the participants'
35 identification responses. A good example of this is the wintergreen odor and its cultural
36 association with sweets and sodas in the North American cultures, and with medicine
37 (muscle balms, mostly) in the European cultures. Spontaneous reactivation of this
38 information triggers well-differentiated affective responses to the smell itself (more positive in
39 the American populations). The link between the content of semantic information participants
40 attach to the odor and the EOSs responses to it has been studied and described elsewhere
41 (Ferdenzi et al. 2013). Therefore, another limit of our tool is that there is some uncontrolled
42 variation in the affective response to odors due to associated products and contexts in
43 memory (e.g., food vs. nonfood contexts). However, the extent of this noise remains
44 restricted since high levels of inter-rater agreement were obtained (see Cronbach's alphas in
45 Table 3) for all categories in all cultures.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Fourth, it must be acknowledged that an extension of this line of studies to very important population groups like Spanish-speaking or African cultures is lacking and would deserve to be conducted in the future. Although it can be predicted that affective categories similar to the ones common to all the cultures we studied would result from such investigations (Disgust, Happiness, Desire and Energy), examination of the culture-specific categories would be have been of interest and it cannot be excluded that it could have led to a slightly different universal (UniGEOS) scale.

To conclude, given the past studies and the results of the present study, we think that the new general model UniGEOS measuring self-reported odor-related affective feelings might not only be useful to carry on fundamental research in this field but might also be especially relevant for applied science investigating the complex relationships between odors and elicited affective states.

Acknowledgments

The authors wish to thank all the people who ensured an efficient data collection in the new cultures presented in this paper, namely Jean-François Meullenet, Joshua Tubbs, and Lydia Rice in Fayetteville, Peiyao Chen and Bingle Chen in Beijing, and Wellington da Silva, André Xavier, Ellen Osbourn and Bob Wyatt in Campinas. Britta Komaromi is also thanked for her help with the Chinese translation. Nadine Gaudreau and Jeannine Delwiche from Firmenich are very much thanked for technical, logistic help and introduction to collaborators.

Furthermore, we extend our grateful appreciation to Olivier Rosset and Dajana Kapusova from the Swiss Center for Affective Science, for their precious help in dealing with the testing web interface. This research was supported by a grant from Firmenich to CF and SD, and by the National Center of Competence in Research (NCCR) Affective Sciences financed by the Swiss National Science Foundation.

References

- 1
2 Alaoui-Ismaili O, Robin O, Rada H, Dittmar A, Vernet-Maury E. 1997. Basic emotions evoked by odorants:
3 comparison between autonomic responses and self-evaluation. *Physiol Behav.* 62:713–720.
- 4 Bensafi M, Rouby C, Farget V, Bertrand B, Vigouroux M, Holley A. 2002a. Autonomic nervous system
5 responses to odours: the role of pleasantness and arousal. *Chem Senses.* 27:703–709.
- 6 Bensafi M, Rouby C, Farget V, Bertrand B, Vigouroux M, Holley A. 2002b. Psychophysiological correlates of
7 affects in human olfaction. *Neurophysiol Clin.* 32:326–332.
- 8
9 Chrea C, Grandjean D, Delplanque S, Cayeux I, Le Calvé B, Aymard L, Velazco MI, Sander D, Scherer KR.
10 2009. Mapping the semantic space for the subjective experience of emotional responses to odors.
11 *Chem Senses.* 34:49–62.
- 12 Churchill A, Behan J. 2010. Comparison of methods used to study consumer emotions associated with
13 fragrance. *Food Qual Prefer.* 21:1108–1113.
- 14 Croy I, Olgun S, Joraschky P. 2011. Basic emotions elicited by odors and pictures. *Emotion.* 11:1331–1335.
- 15 Delplanque S, Chrea C, Grandjean D, Ferdenzi C, Cayeux I, Porcherot C, Le Calvé B, Sander D, Scherer KR.
16 2012. How to map the affective semantic space of scents. *Cogn Emot.* 26:885–898.
- 17 Delplanque S, Grandjean D, Chrea C, Aymard L, Cayeux I, Le Calvé B, Velazco MI, Scherer KR, Sander D.
18 2008. Emotional processing of odors: evidence for a nonlinear relation between pleasantness and
19 familiarity evaluations. *Chem Senses.* 33:469–479.
- 20 Desmet PM, Schifferstein HN. 2008. Sources of positive and negative emotions in food experience.
21 *Appetite.* 50:290–301.
- 22 Desmet PMA. 2006. Typology of fragrance emotions. In: Fellows DS, editor. *Excellence 2006; Esomar*
23 *world research papers.* Amsterdam: Esomar. pp. 309–320.
- 24 Ehrlichman H, Bastone L. 1992. Olfaction and emotion. In: Serby MJ, Chobor KL, editors. *Science of*
25 *Olfaction.* New York: Springer-Verlag. pp. 410–438.
- 26 Ekman P. 1984. Expression and the nature of emotion. In: Scherer KR, Ekman P, editors. *Approaches to*
27 *emotion.* Hillsdale, NJ: Erlbaum. pp. 319–344.
- 28 Engen T. 1982. *The perception of odors.* New York: Academic Press.
- 29 Ferdenzi C, Roberts SC, Schirmer A, Delplanque S, Cekic S, Porcherot C, Cayeux I, Sander D, Grandjean D.
30 2013. Variability of affective responses to odors: Culture, gender, and olfactory knowledge. *Chem*
31 *Senses.* 38:175–186.
- 32 Ferdenzi C, Schaal B, Roberts SC. 2010. Family scents: developmental changes in the perception of kin
33 body odor? *J Chem Ecol.* 36:847–854.
- 34 Ferdenzi C, Schirmer A, Roberts SC, Delplanque S, Porcherot C, Cayeux I, Velazco M-I, Sander D, Scherer
35 KR, Grandjean D. 2011. Affective dimensions of odor perception: a comparison between Swiss,
36 British, and Singaporean populations. *Emotion.* 11:1168–1181.
- 37 Friborg JT, Yuan JM, Wang R, Koh WP, Lee HP, Yu MC. 2008. Incense use and respiratory tract carcinomas:
38 a prospective cohort study. *Cancer.* 113:1676–1684.
- 39 Frijda NH, Scherer KR. 2009. Affect (psychological perspectives). In: Sander D, Scherer KR, editors. *The*
40 *Oxford companion to emotion and the affective sciences.* Oxford: Oxford University Press. p. 10.
- 41 Goel N, Kim H, Lao RP. 2005. An olfactory stimulus modifies nighttime sleep in young men and women.
42 *Chronobiol Int.* 22:889–904.
- 43 Grandjean D, Sander D, Scherer KR. 2008. Conscious emotional experience emerges as a function of
44 multilevel, appraisal-driven response synchronization. *Conscious Cogn.* 17:484–495.
- 45 Guéguen N, Petr C. 2006. Odors and consumer behavior in a restaurant. *Int J Hosp Manag.* 25:335–339.
- 46 Herz RS. 2009. Aromatherapy facts and fictions: a scientific analysis of olfactory effects on mood,
47 physiology and behavior. *Int J Neurosci.* 119:263–290.
- 48 Heuberger E, Redhammer S, Buchbauer G. 2004. Transdermal absorption of (-)-linalool induces
49 autonomic deactivation but has no impact on ratings of well-being in humans.
50 *Neuropsychopharmacology.* 29:1925–1932.
- 51 Hirsch AR. 1995. Effects of ambient odors on slot machine usage in a Las Vegas casino. *Psychol Market.*
52 12:585–594.
- 53 Hu L, Bentler PM. 1999. Cutoff criteria for fit indices in covariance structure analysis: conventional criteria
54
55
56
57
58
59
60
61
62
63
64
65

versus alternatives. *Struct Equ Modeling*. 6:1–55.

- 1 Keltner D, Gross JJ. 1999. Functional accounts of emotions. *Cogn Emot*. 13:467–480.
- 2 King SC, Meiselman HL. 2010. Development of a method to measure consumer emotions associated with
3 foods. *Food Qual Prefer*. 21:168–177.
- 4 Kline P. 1993. *Handbook of psychological testing*. London: Routledge.
- 5 Knasko SC. 1989. Ambient odor and shopping behavior. *Chem Senses*. 14:718.
- 6 Knasko SC. 1992. Ambient odor's effect on creativity, mood, and perceived health. *Chem Senses*. 17:27–35.
- 7 Knasko SC. 1995. Pleasant odors and congruency: effects on approach behavior. *Chem Senses*. 20:479–
8 487.
- 9 Kotler P. 1973. Atmospherics as a marketing tool. *J Retail*. 49:48–64.
- 10 Lehrner J, Marwinski G, Lehr S, Jöhren P, Deecke L. 2005. Ambient odors of orange and lavender reduce
11 anxiety and improve mood in a dental office. *Physiol Behav*. 86:92–95.
- 12 Lenochová P, Vohnoutová P, Roberts SC, Oberzaucher E, Grammer K, Havlíček J. 2012. Psychology of
13 fragrance use: perception of individual odor and perfume blends reveals a mechanism for
14 idiosyncratic effects on fragrance choice. *PLoS ONE*. 7:e33810.
- 15 Markus H, Kitayama S. 1991. Culture and the self - Implications for cognition, emotion, and motivation.
16 *Psychol Rev*. 98:224–253.
- 17 Matsumoto D, Ekman P. 2009. Basic emotions. In: Sander D, Scherer KR, editors. *The Oxford companion to
18 emotion and the affective sciences*. Oxford: Oxford University Press. pp. 69–72.
- 19 Middleton KL, Jones JL. 2000. Socially desirable response sets: The impact of country culture. *Psychol
20 Mark*. 17:149–163.
- 21 Milinski M, Wedekind C. 2001. Evidence for MHC-correlated perfume preferences in humans. *Behav Ecol*.
22 12:140–149.
- 23 Morrin M, Ratneshwar S. 2000. The impact of ambient scent on evaluation, attention, and memory for
24 familiar and unfamiliar brands. *J Bus Res*. 49:157–165.
- 25 Muthén LK, Muthén BO. 2010. *Mplus user's guide*. Los Angeles, CA: Muthén & Muthén.
- 26 Pangborn RM, Guinard J-X, Davis RG. 1988. Regional aroma preferences. *Food Qual Prefer*. 1:11–19.
- 27 Porcherot C, Delplanque S, Gaudreau N, Cayeux I. 2013. Seeing, smelling, feeling! Is there an influence of
28 color on subjective affective responses to perfumed fabric softeners? *Food Qual Prefer*. 27:161–
29 169.
- 30 Porcherot C, Delplanque S, Planchais A, Gaudreau N, Accolla R, Cayeux I. 2012. Influence of food odorant
31 names on the verbal measurement of emotions. *Food Qual Prefer*. 23:125–133.
- 32 Porcherot C, Delplanque S, Raviot-Derrien S, Le Calvé B, Chrea C, Gaudreau N, Cayeux I. 2010. How do you
33 feel when you smell this? Optimization of a verbal measurement of odor-elicited emotions. *Food
34 Qual Prefer*. 21:938–947.
- 35 Rieunier S. 2002. *Le Marketing sensoriel du point de vente* : Créer et gérer l'ambiance des lieux
36 commerciaux. Paris (France): Dunod.
- 37 Rotton J. 1983. Affective and cognitive consequences of malodorous pollution. *Basic Appl Soc.Psychol*.
38 4:171–191.
- 39 Russell JA. 1980. A circumplex model of affect. *J Pers Soc Psychol*. 39:1161–1178.
- 40 Scherer KR. 1994. Emotion serves to decouple stimulus and response. In: Ekman P, Davidson R, editors.
41 *The nature of emotion: Fundamental questions*. New York: Oxford University Press. pp. 127–130.
- 42 Scherer KR. 2009. Feelings (psychological perspectives). In: Sander D, Scherer KR, editors. *Oxford
43 companion to emotion and the affective sciences*. Oxford: Oxford University Press. pp. 183–184.
- 44 Schifferstein HN, Blok ST. 2002. The signal function of thematically (In)congruent ambient scents in a
45 retail environment. *Chem Senses*. 27:539–549.
- 46 Schiffman SS, Miller EA, Suggs MS, Graham BG. 1995a. The effect of environmental odors emanating from
47 commercial swine operations on the mood of nearby residents. *Brain Res Bull*. 37:369–375.
- 48 Schiffman SS, Sattely-Miller EA, Suggs MS, Graham BG. 1995b. The effect of pleasant odors and hormone
49 status on mood of women at midlife. *Brain Res Bull*. 36:19–29.
- 50 Seo H-S, Roidl E, Müller F, Negoias S. 2010. Odors enhance visual attention to congruent objects. *Appetite*.
51 54:544–549.

- 1 Spangenberg ER, Crowley AE, Henderson PW. 1996. Improving the store environment: do olfactory cues
2 affect evaluations and behaviors? *J Marketing*. 60:67–80.
- 3 Stevenson RJ. 2010. An initial evaluation of the functions of human olfaction. *Chem Senses*. 35:3–20.
- 4 Torii S, Fukado H, Kanemoto H, Miyanchi R, Hamauzu Y, Kawasaki M. 1988. Contingent negative variation
5 (CNV) and the psychological effects of odour. In: Van Toller S, Dodd GH, editors. *Perfumery - The
6 Psychology and Biology of Fragrance*. London: Chapman & Hall. pp. 107–120.
- 7 Wedekind C, Seebeck T, Bettens F, Paepke AJ. 1995. MHC-dependent mate preferences in humans. *Proc R
8 Soc B*. 260:245–249.
- 9 Weisfeld GE, Czilli T, Phillips KA, Gall JA, Lichtman CM. 2003. Possible olfaction-based mechanisms in
10 human kin recognition and inbreeding avoidance. *J Exp Child Psychol*. 85:279–295.
- 11 Yeshurun Y, Sobel N. 2010. An odor is not worth a thousand words: from multidimensional odors to
12 unidimensional odor objects. *Annu Rev Psychol*. 61:219–241, C1–5.
- 13 Zentner M, Grandjean D, Scherer KR. 2008. Emotions evoked by the sound of music: characterization,
14 classification, and measurement. *Emotion*. 8:494–521.
- 15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Figure legend

Figure 1. Representation of the seven geographic areas on the two first dimensions of the Multi-Dimensional Scaling MDS analyses for the EOS (Emotion and Odor Scales) categories, familiarity, liking, and correct identification. Black circles represent the groups obtained with the cluster analyses (Ward's method on city-block Manhattan distances). BR=Brazil, CH=Switzerland, CN=China, SG=Singapore, UK=United Kingdom, US1=United States Arkansas, US2=United States California.

Figure 1

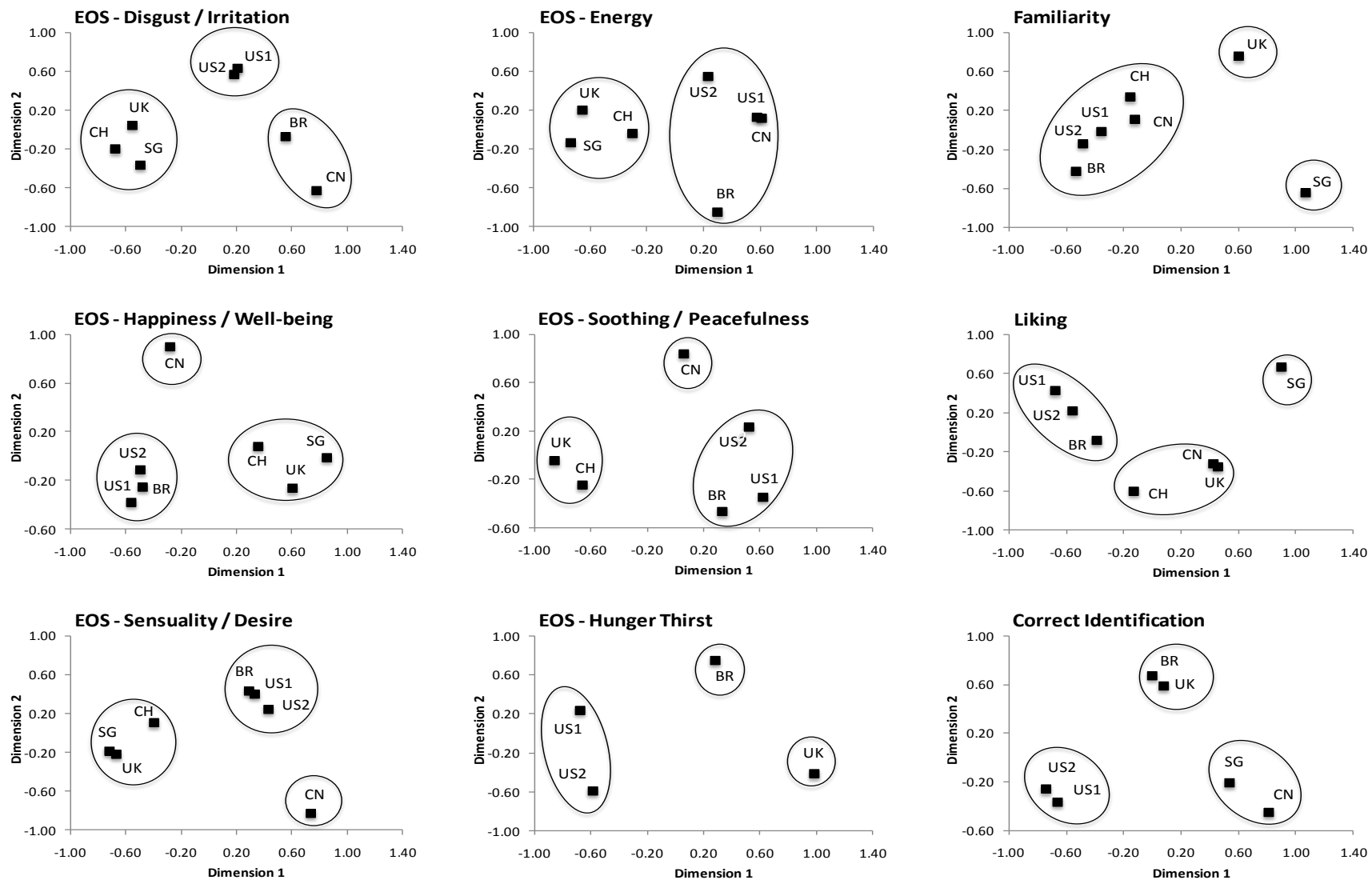


Table 1 Sample size, gender (% men), age (mean \pm standard deviation, range in years) and % smokers in the groups of participants in Study 1, 2 and 3, in each of the seven geographic areas investigated.

	N	(% men)	Age (M\pmSD, range)	% Smokers
EUROPE				
Geneva, CH^a				
Study 1	220	(29%)	31.7 \pm 11.5 (19-60)	21%
Study 2	37	(32%)	24.6 \pm 5.1 (16-37)	19%
Study 3	210	(28%)	37.8 \pm 12.1 (16-65)	21%
Liverpool, UK^b				
Study 1	148	(35%)	21.7 \pm 3.4 (18-35)	11%
Study 2	41	(46%)	23.6 \pm 5.1 (18-40)	12%
Study 3	351	(41%)	32.3 \pm 13.8 (16-78)	18%
AMERICA				
Fayetteville, AR, USA				
Study 1	199	(42%)	25.8 \pm 6.6 (16-49)	6%
Study 2	40	(50%)	23.5 \pm 6.9 (18-55)	8%
Study 3	301	(49%)	41.2 \pm 14.8 (18-74)	9%
Davis, CA, USA				
Study 1	170	(42%)	22.5 \pm 4.4 (18-42)	5%
Study 2	40	(50%)	21.2 \pm 3.2 (18-29)	8%
Study 3	301	(33%)	39.3 \pm 15.2 (18-78)	10%
Campinas, BR				
Study 1	151	(42%)	27.3 \pm 9.8 (18-61)	58%
Study 2	40	(40%)	21.3 \pm 3.8 (17-32)	5%
Study 3	234	(45%)	30.1 \pm 11.9 (16-65)	10%
ASIA				
Singapore, SG^b				
Study 1	105	(27%)	20.7 \pm 1.4 (18-24)	4%
Study 2	38	(29%)	21.1 \pm 1.9 (19-30)	3%
Study 3	211	(41%)	30.0 \pm 9.0 (16-58)	8%
Beijing, CN				
Study 1	100	(27%)	21.8 \pm 2.6 (18-32)	3%
Study 2	38	(42%)	21.9 \pm 2.1 (18-26)	0%
Study 3	293	(37%)	33.3 \pm 12.6 (16-73)	14%

^a Chrea et al. (2009)

^b Ferdenzi et al. (2011)

Table 2 Goodness of fit indices for the best model found in each geographic area following Confirmatory Factor Analysis.

Model	Number of observations	Number of dependent variables	Number of latent variables	χ^2	df ^a	RMSEA	CFI
Geneva, CH ^b	1401	36	6	2262.37	579	0.046	0.924
Liverpool, UK ^c	2448	37	7	2358.47	608	0.034	0.943
Fayetteville, AR, USA	2104	37	6	2482.05	614	0.038	0.966
Davis, CA, USA	2100	37	7	2906.65	608	0.042	0.952
Campinas, BR	1717	33	7	1967.63	474	0.043	0.952
Singapore, SG ^c	1554	36	7	1625.03	573	0.034	0.947
Beijing, CN	2117	37	7	1328.50	608	0.024	0.983

^a df = degrees of freedom.

^b Data presented in Chrea et al. (2009).

^c Data presented in Ferdenzi et al. (2011).

Table 3a Emotion and Odor Scales developed in Switzerland, United Kingdom and the United States (Arkansas and California): the title of the category appears in bold together with the Cronbach's alpha (α , inter-rater agreement) per category; Est.: parameter estimate given by the Confirmatory Factor Analysis; Alpha: Cronbach's alpha per term. In grey: categories common to at least four of the seven studied geographic areas.

Geneva, CH			Liverpool, UK			Fayetteville, AR, USA			Davis, CA, USA		
DISGUST/IRRITATION ($\alpha=.92$)	Est.	Alpha	DISGUST/IRRITATION ($\alpha=.94$)	Est.	Alpha	DISGUST/IRRITATION ($\alpha=.95$)	Est.	Alpha	DISGUST/IRRITATION ($\alpha=.93$)	Est.	Alpha
unpleasant (désagréable)	1.00	0.93	unpleasant	1.00	0.96	unpleasant	1.00	0.96	unpleasant	1.00	0.94
disgusted (dégoûté)	0.92	0.93	disgusted	0.94	0.95	disgusted	0.97	0.96	disgusted	0.97	0.94
unpleasantly surprised (désagréablement surpris)	0.88	0.92	repelled	0.88	0.94	dissatisfaction	0.97	0.95	repulsed	0.97	0.94
sickening (nauséeux)	0.83	0.89	sick	0.88	0.94	repulsed	0.96	0.95	dissatisfaction	0.90	0.92
dissatisfaction (insatisfaction)	0.78	0.90	nauseous	0.83	0.94	unpleasantly surprised	0.88	0.93	nauseous	0.89	0.93
dirty (sale)	0.67	0.90	unpleasantly surprised	0.80	0.93	irritated	0.87	0.94	irritated	0.87	0.92
irritated (irrité)	0.67	0.87	uncomfortable	0.79	0.94	nauseous	0.86	0.94	sick	0.85	0.92
angry (en colère)	0.42	0.78	dirty	0.74	0.94	dirty	0.82	0.95	unpleasantly surprised	0.78	0.90
HAPPINESS/WELL-BEING ($\alpha=.89$)			HAPPINESS/WELL-BEING ($\alpha=.93$)			HAPPINESS/WELL-BEING ($\alpha=.96$)			HAPPINESS/WELL-BEING ($\alpha=.93$)		
pleasant (agréable)	1.00	0.92	in a good mood	1.00	0.93	delighted	1.00	0.96	happy	1.00	0.93
well-being (bien être)	0.94	0.90	pleasantly surprised	0.94	0.93	happy	1.00	0.96	delighted	0.99	0.93
pleasantly surprised (agréablement surpris)	0.94	0.87				smiling	0.98	0.96	pleasure	0.97	0.93
happiness (bonheur)	0.90	0.87				joyful	0.98	0.96	satisfaction	0.95	0.93
attracted (attiré)	0.85	0.83	SENSUALITY/DESIRE ($\alpha=.86$)			likeable	0.97	0.96	fantastic	0.87	0.92
feeling awe (émerveillé)	0.66	0.77	attracted	1.00	0.88	pleasantly surprised	0.97	0.96			
			romantic	0.93	0.89	satisfaction	0.95	0.96			
			sensual	0.91	0.85	pleasure	0.95	0.96	SENSUALITY/DESIRE ($\alpha=.88$)		
SENSUALITY/DESIRE ($\alpha=.78$)			desire	0.91	0.84	fantastic	0.89	0.96	romantic	1.00	0.89
sensual (sensuel)	1.00	0.82	sexy	0.82	0.83	bliss	0.88	0.95	affectionate	0.99	0.90
desire (désir)	1.00	0.76	in love	0.81	0.84				attracted	0.97	0.90
romantic (romantique)	0.95	0.83	to feel intimacy	0.74	0.80	SENSUALITY/DESIRE ($\alpha=.92$)			desire	0.97	0.88
in love (amoureux)	0.95	0.80	lustful	0.74	0.77	romantic	1.00	0.93	sensual	0.96	0.84
sexy (sexy)	0.86	0.75				passionate	0.99	0.93	intimate	0.94	0.86
admiration (admiration)	0.73	0.64	ENERGY ($\alpha=.92$)			sensual	0.99	0.93	in love	0.93	0.88
excited (excité)	0.70	0.63	refreshed	1.00	0.94	intimate	0.97	0.92	sexually aroused	0.77	0.78
			clean	0.95	0.94	sexy	0.96	0.92			
ENERGY ($\alpha=.88$)			revitalized	0.85	0.89	desire	0.94	0.93	ENERGY ($\alpha=.90$)		
revitalized (revitalisé)	1.00	0.87	rejuvenated	0.76	0.88	in love	0.93	0.93	enthusiastic	1.00	0.92
invigorated (tonifié)	0.98	0.86	stimulated	0.70	0.80	sexually aroused	0.81	0.88	excited	0.97	0.88
energetic (énergique)	0.93	0.86	energetic	0.69	0.84				jolly	0.95	0.91
refreshed (rafraîchi)	0.92	0.90				ENERGY ($\alpha=.94$)			energetic	0.93	0.90
clean (propre)	0.91	0.90	SOOTHING/PEACEFULNESS ($\alpha=.89$)			refreshed	1.00	0.96			
stimulated (stimulé)	0.90	0.83	relaxed	1.00	0.90	revitalized	0.97	0.96	SOOTHING/PEACEFULNESS ($\alpha=.93$)		
shivering (frissonnant)	0.38	0.38	soothed	0.99	0.92	energetic	0.86	0.95	peaceful	1.00	0.92
			peaceful	0.97	0.89	interesting	0.66	0.90	soothed	1.00	0.92
SOOTHING/PEACEFULNESS ($\alpha=.81$)			comforted	0.96	0.91	wild	0.50	0.77	relaxed	0.99	0.91
relaxed (relaxé)	1.00	0.81	dreamy	0.86	0.86				calm	0.98	0.91
serene (serein)	0.96	0.81	meditative	0.65	0.70	SOOTHING/PEACEFULNESS ($\alpha=.95$)			refreshed	0.95	0.95
soothed (apaisé)	0.95	0.80	protected	0.51	0.63	comfortable	1.00	0.95	serene	0.95	0.90
reassured (réconforté)	0.90	0.80	drowsy	0.21	0.52	soothed	0.99	0.95	clean	0.88	0.95
light (léger)	0.73	0.82				comforted	0.99	0.95			
			HUNGER/THIRST ($\alpha=.77$)			relaxed	0.96	0.94	HUNGER/THIRST ($\alpha=.89$)		
SENSORY PLEASURE ($\alpha=.79$)			mouth-watering	1.00	0.81				mouth-watering	1.00	0.93
nostalgic (nostalgique)	1.00	0.77	thirsty	0.68	0.60	HUNGER/THIRST ($\alpha=.92$)			thirsty	0.60	0.75
amusement (amusement)	0.98	0.76	famished	0.54	0.61	mouth-watering	1.00	0.95			
mouth-watering (salivant)	0.92	0.82				thirsty	0.49	0.82	NEGATIVE FEELINGS ($\alpha=.87$)		
			NOSTALGIA ($\alpha=.73$)						stressed	1.00	0.87
			sentimental	1.00	0.81				sad	0.65	0.72
			nostalgic	0.82	0.54				ashamed	0.56	0.68

Table 3b Emotion and Odor Scales developed in Brazil and Asian countries (China and Singapore): the title of the category appears in bold together with the Cronbach's alpha (α , inter-rater agreement) per category; Est.: parameter estimate given by the Confirmatory Factor Analysis; Alpha: Cronbach's alpha per term. In grey: categories common to at least four of the seven studied geographic areas.

Campinas, BR			Beijing, CN			Singapore, SG		
DISGUST/IRRITATION ($\alpha=.89$)			DISGUST/IRRITATION ($\alpha=.91$)			DISGUST/IRRITATION ($\alpha=.92$)		
unpleasant (desagradável)	Est. 1.00	Alpha 0.91	to have an aversion to (对...产生厌恶)	Est. 1.00	Alpha 0.92	unpleasant	Est. 1.00	Alpha 0.93
bothered (incomodado)	0.98	0.90	disgusted (厌恶的)	1.00	0.92	horrible	0.96	0.93
nauseous (enaseado)	0.93	0.90	boredom (厌烦)	0.98	0.93	disgusted	0.95	0.92
disgusted (enojado)	0.92	0.89	sick (恶心的)	0.98	0.93	uncomfortable	0.95	0.93
to have an aversion to (ter aversão a)	0.92	0.89	dissatisfaction (不满)	0.94	0.91	sick	0.88	0.91
dissatisfaction (insatisfação)	0.90	0.89	annoyed (使烦闷的)	0.88	0.91	irritated	0.82	0.89
unpleasantly surprised (desagradavelmente surpreso)	0.88	0.88	unpleasant (不愉快的)	0.87	0.89	unpleasantly surprised	0.67	0.84
irritated (irritado)	0.80	0.85	irritated (恼怒的)	0.84	0.90	dirty	0.62	0.89
			dirty (肮脏的)	0.84	0.89			
HAPPINESS/WELL-BEING ($\alpha=.92$)			HAPPINESS/WELL-BEING ($\alpha=.93$)			HAPPINESS/WELL-BEING ($\alpha=.88$)		
well-being (bem-estar)	1.00	0.93	agreeable (使人愉快的)	1.00	0.94	pleasant	1.00	0.91
happy (feliz)	0.97	0.92	titillated (使愉快的)	0.99	0.94	relaxed	0.94	0.90
comfortable (confortável)	0.97	0.92	joyful (愉快的)	0.99	0.93	comforted	0.89	0.87
joyful (contente)	0.94	0.92	in a good mood (心情好的)	0.99	0.93	happiness	0.85	0.86
amusement (diversão)	0.77	0.88	cheerful (使人感到愉快的)	0.99	0.92	pleasantly surprised	0.76	0.83
			beaming (喜悦的)	0.98	0.94	well-being	0.72	0.83
			happy (幸福的)	0.97	0.92			
SENSUALITY/DESIRE ($\alpha=.87$)			SENSUALITY/DESIRE ($\alpha=.90$)			SENSUALITY/DESIRE ($\alpha=.76$)		
charmed (seduzido)	1.00	0.89	romantic (浪漫的)	1.00	0.93	charmed	1.00	0.80
desire (desejo)	1.00	0.87	charmed (迷人的)	0.98	0.89	romantic	0.99	0.81
passionate (apaixonado)	0.99	0.90	desire (渴望)	0.97	0.90	adoring	0.95	0.78
sensual (sensual)	0.98	0.86				desire	0.92	0.70
romantic (romântico)	0.96	0.90				in love	0.91	0.77
sexy (sexy)	0.96	0.85				sensual	0.88	0.75
sexually aroused (excitado (sexualmente))	0.85	0.84				admiration	0.76	0.65
fiery (fogososo)	0.79	0.78				sexy	0.76	0.62
						sexually aroused	0.60	0.41
ENERGY ($\alpha=.91$)			ENERGY ($\alpha=.91$)			ENERGY ($\alpha=.89$)		
refreshed (refrescado)	1.00	0.93	rejuvenated (恢复青春活力的)	1.00	0.92	refreshed	1.00	0.92
purified (purificado)	0.99	0.90	animated (生气勃勃的)	0.99	0.92	revitalized	0.90	0.87
invigorated (revigorado)	0.97	0.89	energetic (精力充沛的)	0.98	0.90	energetic	0.65	0.84
			vitality (活力)	0.97	0.92			
SOOTHING/PEACEFULNESS ($\alpha=.90$)			SOOTHING/PEACEFULNESS ($\alpha=.91$)			NEGATIVE FEELINGS ($\alpha=.64$)		
relaxed (relaxado)	1.00	0.91	revitalized (恢复生机的)	0.97	0.91	stressed	1.00	0.70
comforted (confortado)	0.98	0.91	refreshed (恢复精神的)	0.95	0.90	depressed	0.80	0.57
at peace (em paz)	0.98	0.89				angry	0.71	0.68
calm (calmo)	0.96	0.89				sad	0.58	0.44
relieved (aliviado)	0.87	0.88				boredom	0.43	0.08
HUNGER/THIRST ($\alpha=.88$)			AROUSAL ($\alpha=.66$)			INTELLECTUAL STIMULATION ($\alpha=.76$)		
mouth-watering (com água na boca)	1.00	0.89	impressed (印象深刻的)	1.00	0.71	interesting	1.00	0.70
famished (faminto)	0.67	0.83	psychologically affected (心理上有影响的)	0.98	0.44	fascinated	0.94	0.77
						amusement	0.60	0.44
NOSTALGIA ($\alpha=.73$)			MELANCHOLY ($\alpha=.82$)			SPIRITUALITY ($\alpha=.60$)		
homesick/nostalgic (saudosos)	1.00	0.78	depressed (沮丧的)	1.00	0.87	spiritual feeling	1.00	0.55
nostalgic (nostálgico)	0.79	0.66	sad (伤心的)	0.95	0.77	religious feeling	0.40	0.61
			melancholic (忧郁的)	0.94	0.80			
			sentimental (伤感的)	0.92	0.80			

Table 4. Proposed universal Emotion and Odor Scale (UniGEOS) with 9 affective categories and 25 affective terms in four languages. N is the number of geographic areas (out of the seven studied) in which the term appears.

English	French	Chinese	Portuguese
1. UNPLEASANT FEELINGS			
disgusted (N=7)	dégoûté	厌恶的	enojado
irritated (N=6)	irrité	恼怒的	irritado
unpleasantly surprised (N=6)	désagréablement surpris	不愉快的意外惊喜	desagradavelmente surpreso
2. HAPPINESS / DELIGHT			
happy (N=6)	heureux	幸福的	feliz
pleasantly surprised (N=5)	agréablement surpris	惊喜的	agradavelmente surpreso
well-being (N=3)	bien-être	安宁	bem-estar
3. SENSUALITY / DESIRE			
desire (N=7)	désir	渴望	desejo
romantic (N=7)	romantique	浪漫的	romântico
sensual (N=6)	sensuel	肉欲的	sensual
4. ENERGY			
refreshed (N=7)	rafraîchi	恢复精神的	refrescado
energetic (N=6)	énergique	精力充沛的	energético
revitalized (N=5)	revitalisé	恢复生机的	revitalizado
5. SOOTHING / PEACEFULNESS			
relaxed (N=7)	relaxé	得到安宁的	relaxado
comforted (N=5)	réconforté	宽慰的	confortado
soothed (N=4)	apaisé	受安慰的	sossegado
6. HUNGER / THIRST			
mouth-watering (N=5)	salivant	令人垂涎欲滴的	com água na boca
thirsty (N=3)	assoiffé	口渴的	sedento
famished (N=2)	affamé	极饥饿的	faminto
7. INTEREST			
amusement (N=3)	amusement	娱乐	diversão
interesting (N=2)	captivant	有趣的	interessante
impressed (N=1)	impressionné	印象深刻的	impressionado
8. NOSTALGIA			
sad (N=3)	triste	伤心的	triste
melancholic (N=1)	mélancolique	忧郁的	melancólico
nostalgic (N=3)	nostalgique	怀旧的	nostálgico
9. SPIRITUALITY			
spiritual feeling (N=1)	sentiment spirituel	精神感觉	sentimento espiritual