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Development of a memories vocabulary (MemVOC) for food products using coffee as a model

Adan CABAL-PRIETO[1], Gabriela TEODORO-BERNABÉ[1], Cecilia CORIA-RINCÓN[1], Lucia SÁNCHEZ-ARELLANO[1], Lorena Guadalupe RAMÓN-CANUL[2], Jesús RODRÍGUEZ-MIRANDA[3], Witoon PRINYAWIWATKUL[4], José Manuel JUÁREZ-BARRIENTOS[5], José Andrés HERRERA-CORREDOR[6*], Emmanuel de Jesús RAMÍREZ-RIVERA[7*]

Abstract

Multiple references in sensory science indicate that foods evoke memories during consumption, however, research regarding those memories is still limited. The objective of this study was to develop a vocabulary and implement it in a memories vocabulary related to food as a complement for the evaluation of sensory attributes and emotions, using coffee as a model. The memories vocabulary was generated with a series of successive studies that involved assigning positive and negative memories to different food groups and applying mathematical algorithms (WordCountAna and Factorial Approach) and contrasting memories with the scientific literature. Subsequently, the vocabulary was used to determine the profile of memories and their association with sensory attributes and emotions in coffee samples evaluated by trained judges and consumers. The memories vocabulary consisted of a total of 14 and 12 positive and negative memories terms, respectively. The vocabulary of memories was used in a similar way by both panels allowing them to differentiate between artisanal and industrial coffees. The memories vocabulary of the coffees showed a positive association with sensory attributes and emotions, thus achieving a more robust explanation of the samples used in the research.

Keywords: artisan and industrial coffees; emotions; food-related memories; sensory attributes.

Practical Application: The memories vocabulary can help to understand the impact of food on the consumer's memories, this allows the generation of a new paradigm for a comprehensive characterization of food including sensory characteristics, memories, and emotions. Our proposal is to use a memories vocabulary to help respondents retrieve those memories in a systematic way that can be further analyzed using a diversity of statistical techniques.

1 Introduction

Market demand and consumer preferences are constantly evolving (Braun-Endo & Brás-Roque, 2017). In order to deal with changes in market needs, the food industry has focused on finding sensory attributes that have an impact on consumer preference (Ramírez-Rivera et al., 2018) and purchase intent. However, sensory attributes of food products are not the only determining factor in choosing a food by consumer, and emotions can also influence purchase intent (Köster, 2003; King & Meiselman, 2010; Jiang et al., 2014). Currently, the field of sensometry has developed techniques for the evaluation of sensory attributes and emotions in different foods such as wines, freshness of chicken breast, tortillas, among others (Jose-Coutinho et al., 2015; Oliveira e Silva et al., 2020; Santiago-Cruz et al., 2021), and food neophobia scales have even been developed (McKenzie et al., 2021). According to Köster (2003) most sensory research is based on perception and scarcely on the use of memories in the choice of food. Despite these efforts, a gap still exists between sensory attributes and emotions that has not yet been fully explored. In this regard memories that are considered as prominent signals and lived in the mind of the consumer can influence their attitudes, emotions, and purchase intent (Herz & Brunk, 2017). This void is related to the memories that are the autobiographical events that a person experiences (e. g., places, events, among others) (Sester et al., 2013). According to Mark et al. (1992) and Navarro Bravo et al. (2008), memories are divided into extended (those that last for more than one day, such as childhood), categorical (those that refer to repeated actions such as Christmas) and specific (those specific moments in a specific space and time such as celebrations). They can also be classified as negative (which refer to traumatic events) or positive (that are happy and pleasant memories of great impact; Manzanero et al. (2015). According to Lin & Mao (2015), food products can generate

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[1] *Tecnológico Nacional de México, Campus Huatusco, Huatusco, Veracruz, México*
[2] *Tecnológico Nacional de México, Campus Mérida, Mérida, Yucatán, México*
[3] *Tecnológico Nacional de México, Campus Tuxtepec, Tuxtepec, Oaxaca, México*
[4] *School of Nutrition and Food Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA, EUA*
[5] *Universidad del Papaloapan, Campus Loma Bonita, Loma Bonita, Oaxaca, México*
[6] *Colegio de Postgraduados, Campus Córdoba, Amatlán de los Reyes, Veracruz, México*
[7] *Tecnológico Nacional de México, Campus Zongolica, Zongolica, Veracruz, México*
*Corresponding authors: ejramirezrivera@zongolica.tecnm.mx, jandreshc@colpos.mx

different memories, as other objects do (e.g., postcard, t-shirt, among others) due to their sensory characteristics which can influence purchase intent (Vidal et al., 2013). A clear example is the evaluation of the odors that travel through the nostrils to the olfactory epithelium where they are then decoded in the orbitofrontal cortex and reinforced by the functions of the amygdala to provide information about food (Gierczynski et al., 2011; Broche-Pérez et al., 2016). This process results in complex semantic and cognitive construct through the relationship of memories about a food and the experiences stored in the consumer's memories (Bettman, 1979; Morin-Audebrand et al., 2009). Currently, research using sensory memories has been focused on aspects such as texture of food (Mojet & Köster, 2005), flavor and aromas (Morin-Audebrand et al., 2009), development of food souvenirs (Lin & Mao, 2015), determination of false memories in preference, among others (Howe et al., 2017; Aiello et al., 2018). However, these studies do not specifically indicate the memories generated by the tested food products. Although in the field of psychology there are different techniques to evaluate memories (e.g., autobiographical memories test, face and feelings test, among others), these cannot be easily adapted to the sensory evaluation context due to their execution time and result interpretation (Ricarte et al., 2013). Therefore, there is a need to generate a vocabulary of memories that can be integrated with different sensory techniques (e. g., Check-All-The-Apply-CATA, among others) to determine a profile of memories generated by food products during consumption and that can influence consumer decision-making (Vidal et al., 2018; Shaw & Bagozzi, 2018). The objective of this research was to develop a vocabulary and implement it in a memories vocabulary related to food as a complement for the evaluation of sensory attributes and emotions, using coffee as a model.

2 Materials and methods

The study was carried out in two successive phases. Phase 1) generation of memories vocabulary using an online questionnaire. Phase 2) application of the vocabulary of memories for the generation of a profile of memories in artisanal and industrial coffees.

2.1 Phase 1: generation of food-related memories vocabulary

To carry out this phase, the following steps were followed: *Step 1)* Different food groups were considered: Group 1: dairy, Group 2: fruits and vegetables, Group 3: confectionery, Group 4: cereals, Group 5: meat, Group 6: seafood (fish, shrimp), Group 7: eggs, Group 8: soups, Group 9: drinks (coffee, chocolates, soft drinks), Group 10: alcoholic beverages (wines, beers) and Group 11: meals. These foods were also considered in the research of Laguna et al. (2020) who evaluated the impact of COVID-19 on food priorities through an online survey and by Paixão et al. (2020), who evaluated alcoholic and non-alcoholic beverages. From each food group, five digital images were captured using a Panasonic Lumix camera, model DMC-TZ3 with fixed lighting for each shot (Baima & Ribotta, 2019). The use of images for sensory studies using online questionnaires is a valuable tool to find differences among products (Spinelli et al., 2015; Santiago-Cruz et al., 2021). The criteria for selecting the images were: 1) they must be representative of their respective food group, 2) company labels were removed to avoid bias on consumer response, and 3) the images were taken on a white background. *Step 2)* A questionnaire was designed using the Google® Forms tool for collecting memories words associated with each food group mentioned in Step 1. The access link to the questionnaire was distributed using social networks and instant messaging applications where consumers (N= 361) were asked to assign positive or negative words or memories to each food group from step1. Criteria for consumer selection were as follows: 1) availability to answer the survey; 2) consumers aged over 18 years, 3) a middle school education level was required for vocabulary generation. Responses from consumers whom did not meet these conditions were not included in the data analysis. It was indicated to respondents that positive memories are events that generate happiness and negative memories are traumatic events (Manzanero et al., 2015). The purpose was to allow consumers answering the questionnaire to have in mind what was considered a positive and negative memories in the context of the study. The Free Sorting Task (FST) sensory technique was used to generate the vocabulary of memories as follows: each consumer observed the image of a food and then assigned memory words according to their personal experiences. This technique was used as it eliminates biases due to use of a word list (Mahieu et al., 2020). Consumers were also instructed to keep positive and negative memories words short (between 1 to 5 compound words) to facilitate statistical treatment (Kostov et al., 2014). Data were organized in a matrix with i rows and j columns, where each row i corresponded to each food group (i = 11) and column j corresponded to consumers (j = 361 consumers from different parts of Mexico). Each consumer j assigned qualitative variables (memories words) with Kj categories, where Kj is the memory to each food group. The labeling of each category is the sequence of words associated with each of the Kj groups (Cadoret et al., 2009). According to Blancher et al. (2012) and Mahieu et al. (2021), the evaluation of a number of products between 8 and 15 with a range of evaluations between 10-118 or using more than 60 consumers are sufficient to obtain reliable results using the FST technique, since, when less than 50 consumers are used fewer consensual words can be obtained (Kostov et al., 2014). Similarly, the number of consumers surveyed in this study was higher than those used in the research by King & Meiselman (2010) whom used 305 people for the identification, categorization and selection phases in the development of the vocabulary of emotions. *Step 3)* The memories vocabulary validation was carried out in two ways: 1) statistical approach: the fast (Factorial Approach for Sorting Task data) and WordCountAna (Word-Count based methods Analysis) functions (for textual analysis) by Cadoret et al. (2009) and Kostov et al. (2014) were used for determining probability values. Memories with probability values less than 0.05 were retained. 2) searching if the words of selected memories (p <0.05), mentions equal to or higher than 3 (Perrin et al., 2008; Kostov et al., 2014) and which had been reported in the scientific literature referring to the field of psychology. Once the vocabulary was defined according to the previous ways, results between the trained panel and consumers as well as the correlation with data on sensory attributes and emotions were compared for validation.

2.2 Phase 2: application of the vocabulary of memories in coffees: characterization and correlation between memories, sensory attributes, and emotions evaluated by the trained panel and consumers

The objective of this phase was to identify how trained judges and consumers use the memories vocabulary to characterize coffee samples as well as its relationship with sensory attributes and emotions at the trained panel and consumers' level. Coffee was used as a stimulus due to its sensory complexity and the experiences it generates (Bhumiratana et al., 2019). Additionally, coffee is very well known worldwide making it an excellent candidate to serve as a model for the development of our memories vocabulary as it is very probable consumers to have memories associated to this product. Also, the geographical region where this study was conducted (with the trained panel), is actually a coffee production region. The following steps were carried out: Step 1) six coffee samples were evaluated (n = three artisan coffees [AC1, AC2 and AC3] and n = three industrial coffees [IC1, IC2 and IC3]). Artisanal and industrialized coffees were included in the study to find the differences in the memories generated by both types of coffee and because of the high demand for both types of coffees (Favalli et al., 2013). The artisan coffees were acquired from artisan producers and industrialized coffees from convenience stores in the Huatusco region, Veracruz, Mexico. The artisan coffees were prepared as follows: green coffee was prepared according to the guidelines of the ISO standard 6668 (International Organization for Standardization, 2008). Subsequently, the green coffee was roasted following the protocols indicated by the Specialty Coffee Association of America (2009) to get a medium profile roasted coffee. The evaluation of sample coffee was carried out in porcelain cups of 150 mL identified with a three-digit code as indicated in the Specialty Coffee Association of America (2009) and Ramírez-Rivera et al. (2021). Coffee cupping was performed in porcelain cups. A sample of 8 grams of ground coffee was placed in the cup and 150 mL hot water (93 ± 5 °C) was poured. The grounds were allowed to steep for 3 minutes. After this time, the foam layer and particles of the coffee sample were manually removed so it could be evaluated at 40 ± 5°C by the panelists Specialty Coffee Association of America (2009). The industrial coffees were prepared according to the specifications indicated on package label. Step 2) A trained panel and a consumer panel were formed. The trained panel included nine panelists (five men and four women with an age range between 23 and 49 years old) with more than five years of experience in the evaluation of coffee and they have participated in other studies evaluating a diversity of coffee varieties and coffee based food products. Panelists were recruited from the Instituto Tecnológico Superior de Huatusco, Veracruz, Mexico. Consumers (99 people aged 25 to 50 years) were used in the study taking into account their performance in terms of discrimination from previous studies (Worch et al., 2010). Panelists and consumers were selected according to ISO standard 8586-1 (International Organization for Standardization, 1993) and ISO standard 11035 (International Organization for Standardization, 1994). In the first step, the availability and motivation of each person to participate in the project, daily frequency of coffee consumption and no aversion towards it (ISO standard 8586-1, International Organization for Standardization, 1993) were verified. In the second step, subjects were screened through the application of basic taste tests, recognition of aromas (ISO standard 5496, International Organization for Standardization, 2005), triangular discrimination tests (ISO standard 4120, International Organization for Standardization, 2004c) and duo-trio (ISO standard 10399, International Organization for Standardization, 2004a) test. In the third step, the selection was made from the people who made up each test based on their results obtained from the second stage. For this purpose, the Sequential Analysis with triangle technique was performed (ISO standard 16820, International Organization for Standardization, 2004b) with the following parameters: p0 = 0.30, p1 = 0.70, α = 0.10 and β = 0.10). Step 3) Both panels evaluated aroma (Sweet, Caramel, Chocolate, Herbal, Walnut, Burnt, Woody, Cinnamon, Earthy, Coffee peel, Cherry, Moisture, Spicy and Pineapple), taste (Acidic Sweet, Bitter) and flavor (Fruity, Cinnamon, Caramelized, Chocolate, Citric, Fermented, Herbaceous, Smoke, Immature, Woody, Apple, Honey, Burnt, Rancid, Earthy, Roasted and Whiskey). Sensory attributes were determined by a Q-certified panel (six men and three women with an age range between 25-49 years) and using the Specialty Coffee Association of America (2009) coffee flavor wheel. Subsequently, both panels indicated the memories generated by the coffee samples using the vocabulary generated in Phase 1 and the emotions that they evoked according to the EsSense25 emotion vocabulary (Nestrud et al., 2016). For the collection of data on attributes, memories, and emotions, the Check-All-The-Apply (CATA) technique was used (Vidal et al., 2018). The trained panel (nine panelists) carried out a total of 11 repetitions and the consumer panel (99 people) only carried out one repetition in order to balance the number of results and make the results comparable between both panels (Mahieu et al., 2020). It should be noted that all tests (e. g., preliminary tests, analysis of attributes, memories, and emotions) were carried out by the trained panelists and consumers at home to avoid contact among people and minimize the risks of contraction by COVID-19 (Santiago-Cruz et al., 2021). To do this, local parcel services distribute samples of ground coffee for evaluation, the evaluation lists (attributes, memories and emotions), napkins, pencils, water (for cleaning the palate between samples in the case of the flavors) and a digital thermometer (Chef mode, Puebla, México) among participants. Participants informed the project leader when they received samples and materials to start their evaluation. Once the participants received the ground coffee samples, they were asked to prepare the coffee drinks at a temperature of 40 ± 5 °C for evaluation (Specialty Coffee Association of America, 2009). Control temperature was done during training (for the trained panel) and instructing the consumers (consumers panel) regarding the adequate cupping temperature in a preliminary session. A videoconference session using Skype® was scheduled to verify that each participant had no doubts at the time of evaluation and thus proceed to carry out the tests (Nogueira-Terrones et al., 2006). Data generated by both panels were compared in different ways in successive stages: 2) *Use of memories vocabulary*: this stage consisted of determining the significance of each memory using Cochran's Q statistical technique. The Student t-test technique was then applied to determine possible differences in the use of positive

and negative memories between panels. Subsequently, the confidence ellipses (95% and with 500 resamples) and memories map were generated using Correspondence Analysis (CA) for the comparison of memories experienced by both panels (Cadoret & Husson, 2013; Vidal et al., 2018). 3) Correlation between sensory panels: in this stage the memories profile used by both sensory panels was correlated and 3) Correlation of the coffee memory profile with other sensory data: in this stage the memory profile of the coffees was correlated with sensory attributes and emotions per panel. For stages 2 and 3, the Multiple Factor Analysis (MFA) and *Rv* coefficient techniques were used for data analysis (Worch et al., 2010). The Cochran's Q test, *Student t-test*, MFA and *Rv* coefficient were performed with the software XLSTAT software, version 2020 (Addinsoft, New York, NY, USA). The confidence ellipses were constructed with the package SensoMineR (Le & Husson, 2008) implemented in the programming language R version 3.2.5 (R Core Team, 2019).

3 Results and discussion

3.1 Phase 1: generation of memories vocabulary

A total of 359 valid responses from consumers were used for the analysis of survey data with the WordCountAna and FAST functions from the SensoMineR package. The length of the memories words collected was between one to three words. A total of 14 and 12 of positive and negative memories ($p < 0.05$) were generated, respectively (Table 1 and 2). The positive memories *Traditional Food, Party, Family, Birthplace* and *Childhood* had the highest number of mentions (> 80 mentions) and negative memories with the highest number of mentions (> 90 mentions) were *Disease, Pain, Addiction, Hurt* and *Stench* (Tables 1 and 2).

In this phase, memories with significant values were shown according to the results of the WordCountAna and FAST functions. It was found that the positive memories such as *Love*

Table 1. Mention and probability values for positive memories vocabulary.

Memories	Mentions	Probability	Reference
Traditional Food	363	<0.0001	Aiello et al.(2018)
Party	265	<0.0001	Alonso et al. (2004)
Family	229	<0.0001	Rubio-Cordoba (2014); Aiello et al. (2018); Johnson et al. (2020)
Birthplace	193	<0.0001	Alonso et al. (2004)
Childhood	88	<0.0001	Alonso et al. (2004); Navarro Bravo et al. (2008)
Friendship	55	<0.0001	Ricarte et al. (2013); Rubio-Cordoba (2014)
Sport	45	<0.0001	Cho et al. (2019)
Couple	31	<0.0001	Alonso et al. (2004)
[a]Time of the year	31	<0.0001	Alonso et al. (2004)
[b]Climate	12	<0.0001	Alonso et al. (2004)
Alive	7	0.04	Alonso et al. (2004); Johnson et al. (2020)
Gift	3	0.002	Alonso et al. (2004)
Love	10	0.08	Alonso et al. (2004); Johnson et al. (2020)
Nature	5	0.45	Alonso et al. (2004); Johnson et al. (2020)

The probability values were obtained with the WordCountAna and FAST algorithms (Cadoret et al., 2009; Kostov et al., 2014). [a,b] For the positive memories, time of year and climate were defragmented according to the seasons (Spring, Summer, Fall, Winter) and climates (Rainy weather, Cold weather, Hot weather, Mild weather).

Table 2. Mention and probability values for negative memories vocabulary.

Memories	Mentions	Probability	Reference
Disease	686	<0.0001	Alonso et al. (2004); Ricarte et al. (2013)
Pain	221	<0.0001	Alonso et al. (2004); Ricarte et al. (2013)
Addiction	140	<0.0001	Yamada et al. (2014)
Hurt	117	<0.0001	Alonso et al. (2004); Ricarte et al. (2013)
Stench	92	<0.0001	Jiménez (2014)
Death	41	<0.0001	Alonso et al. (2004); Manzanero et al. (2015); Johnson et al. (2020)
Interpersonal conflict	22	<0.0001	Manzanero et al. (2015); Johnson et al. (2020)
Poverty	61	<0.0001	Alonso et al. (2004); Johnson et al. (2020)
Accident	22	<0.0001	Alonso et al. (2004); Rubio-Cordoba (2014); Manzanero et al. (2015)
Obesity	94	0.38	Zeng et al. (2020)
Excesses	81	0.76	Moreno-Padilla et al. (2018); Blau et al. (2020)
Blood	3	0.244	Alonso et al. (2004)

The probability values were obtained with the WordCountAna and FAST algorithms (Cadoret et al., 2009; Kostov et al., 2014).

and *Nature* and the negative memories *Obesity* and *Excesses* were not significant ($p > 0.05$); however, they were considered on the list of memories because they were cited by at least three consumers (Perrin et al., 2008; Kostov et al., 2014). The positive and negative memories found in this research have also been detected in various studies related to false memories and false recognition production indexes (Alonso et al., 2004), design of the Autobiographical Memories Test operation (Ricarte et al., 2013), analysis of aromas in artisan accessories stores (Rubio-Cordoba, 2014), positive and negative memories generated in the context of war (Manzanero et al., 2015), analysis of episodic memories versus natural and processed foods (Aiello et al., 2018), nostalgia for sports tourists in the decision-making process (Cho et al., 2019) and concerns and reflections on the COVID-19 pandemic (Johnson et al., 2020). It is worth mentioning that no research was found that included the use of the word *Obesity* as a memories; However, its use is justified because the usefulness of memories depends not only on current consumption, but also on the usefulness of memory derived from past consumption (Zeng et al., 2020). In the same sense, *Excess* negative memory could have been mentioned by consumers because it is related to hypersensitivity to food stimuli that influence the formation of people's preferences, for example, consumers that have a tendency for the consumption of foods rich in fat or fast foods (Moreno-Padilla et al., 2018; Blau et al., 2020). The word *Addiction* could be mentioned by consumers due to the dependence on products of alcoholic beverages, cola drinks, coffee, among others (Yamada et al., 2014; Bhumiratana et al., 2019). Finally, the negative memories, *Stench* or unpleasant odors is also of importance according to Jiménez (2014) who mentioned that this smell can influence acceptance or rejection of interpersonal relationships and is linked to feelings, sensations, or images such as food (e.g., cheese, fermented food, egg, among others), aspects of personal hygiene, state of conservation of objects or places (e.g., shoes, clothing, closed premises, among others).

3.2 Phase 2: application of the vocabulary of memories in coffees

Use of memories vocabulary

The results on the use of memories vocabulary and their respective probability values are shown in Table 3 and 4. The trained panel responded with positive memories: *Childhood, Couple, Fall, Hot weather, Love* and *Nature*; These positive memories had Cochran´s Q test probability values higher than 0.05. The trained panel minimally used negative memories: *Addiction, Interpersonal conflict, Obesity, Excesses and Blood*, which were not significant ($p > 0.05$). The trained panel responded with 65 and 53% of positive and negative memories, respectively. Table 4 shows the results from the consumer panel indicating that positive memories *Family, Childhood*, *Friendship, Cold weather* and *Mild weather* and negative memories *Disease, Pain, Stench* and *Death* were significant. The consumer panel responded with only five and four positive and negative memories, respectively for characterizing the coffee samples. This represents 25 and 36.36% of positive and negative memories. The results of the Student t-test showed that there were no significant differences in the

Table 3. Number of positive and negative memories mentioned in coffee samples with their respective probability values of the Cochran's Q test of the trained panel.

Positive memories	Mentions	*p* values	Negative memories	Mentions	*p* values
Traditional Food	107	<0.0001	Disease	87	<0.0001
Party	147	ns	Pain	103	<0.0001
Family	174	<0.0001	Addiction	5	ns
Birthplace	178	0.009	Hurt	39	<0.0001
Childhood	13	ns	Stench	40	<0.0001
Friendship	92	<0.0001	Death	59	<0.0001
Sport	4	0.050	Interpersonal conflict	9	ns
Couple	0	ns	Poverty	98	<0.0001
Spring	92	<0.0001	Accident	11	0.001
Summer	88	<0.0001	Obesity	0	ns
Fall	146	ns	Excesses	0	ns
Winter	329	0.004	Blood	0	ns
Rainy weather	243	0.021			
Cold weather	333	0.004			
Hot weather	32	ns			
Mild weather	184	<0.0001			
Alive	40	<0.0001			
Gift	63	<0.0001			
Love	0	ns			
Nature	0	ns			

ns: is not significant. The data resulted from 11 repetitions carried out by the trained panel.

Table 4. Number of positive and negative memories mentioned in coffee samples with their respective probability values of the Cochran's Q test of the consumer panel.

Positive memories	Mentions	*p* values	Negative memories	Mentions	*p* values
Traditional Food	66	ns	Disease	67	0.018
Party	71	ns	Pain	80	<0.0001
Family	129	0.038	Addiction	24	ns
Birthplace	117	ns	Hurt	45	ns
Childhood	45	0.029	Stench	15	0.013
Friendship	79	0.049	Death	62	0.007
Sport	20	ns	Interpersonal conflict	38	ns
Couple	0	ns	Poverty	38	ns
Spring	75	ns	Accident	22	ns
Summer	70	ns	Obesity	8	ns
Fall	128	ns	Excesses	0	ns
Winter	177	ns	Blood	0	ns
Rainy weather	119	ns			
Cold weather	176	0.010			
Hot weather	69	ns			
Mild weather	123	0.008			
Alive	60	ns			
Gift	38	ns			
Love	0	ns			
Nature	0	ns			

ns: is not significant. Data resulted from one repetition conducted by the consumer panel.

use of positive ($t_{positives}$ = 2.25, p= 0.26) and negatives memories ($t_{negatives}$ = 3.66, p= 0.17) between the panels used in this study.

In Figure 1, confidence ellipses and memories maps generated with the data from the trained panel and the consumer panel are shown. Figures 1A and C show that the trained panel and the consumer panel correctly discriminate ($p < 0.05$) artisan coffees (AC1, AC2 and AC3) from industrial coffees (IC1, IC2 and IC3) according to the resulting memories profile. Figure 1 B and D show the memories map of coffees generated by both, trained panel and consumer panel. It was found that the trained panel (Figure 1B), when evaluating the samples of artisanal coffees, experienced positive memories *Traditional Food, Friendship, Mild weather, Birthplace, Spring, Alive, Gift and Summer* while the consumer panel experienced the positive memories *Family, Friendship, Mild weather* and *Rainy weather* for the same artisan coffee samples (Figure 1D). In the same way, the negative memories evoked by the artisan coffees in the trained panel was *Accident* (Figure 1B) and in the case of the consumer panel it was *Disease* (Figure 1D). In the case of industrialized coffees, the trained panel experienced the positive memories *Rainy weather, Cold weather, Winter* and *Sport* (Figure 1B) while the consumer panel associated positive memories *Rainy weather, Cold weather* and *Childhood* (Figure 1D). In the case of negative memories, the trained panel associated the memories *Hurt, Pain, Stench, Death, Poverty* and *Disease* (Figure 1B) while the consumer panel used the following negative memories *Death, Stench* and *Pain* (Figure 1D). Discrimination of *artisanal vs. industrial coffee* samples using confidence ellipses, memories maps per panel and the same direction of positive memories (*Friendship, Family, Cold weather* and *Mild weather*), and the negative memories (*Death, Stench* and *Pain*) in the factorial plane together with the high values of the *Rv* coefficient, indicated that the vocabulary of memories can be used in the context of trained judges and consumers as results were similar. This result is supported by Worch al. (2010), who showed that trained judges and consumers discriminate in a similar way. From the point of view of the use of the profile of memories in conjunction with the sensory attributes and emotions, high values of association were found between different profiles used in both panels. Artisan coffees evoked different positive memories (*Traditional food, Friendship, Mild weather, Birthplace, Spring, Gift, Alive* and *Summer*) and were associated with different sensory attributes typical of coffee with desirable characteristics (e. g, *Cinnamon-F, Cinnamon-A, Caramel-A, Chocolate-A, Chocolate-F, Fruity-F, Caramelized-F, Sweet-A, Sweet-T, Honey-F* and *Nut-A*) and generated the positive emotions found in this research.

Correlation between sensory panels

The correlation between sensory panels using MFA is shown in Figure 2 where a high proximity is observed between both groups (Figure 2A). This was confirmed by the partial clouds (Figure 2B) where the proximity of both sensory panels to the midpoint represented by each coffee sample was observed. The aforementioned proximity was verified by a correlation value $Rv_{trained\text{-}consumers}$ = 0.92 ($p \leq 0.05$). This result could be due to the positive memories Family, Friendship, Cold weather, *Mild weather* as well as negative memories *Death, Stench* and *Pain* which showed similar direction in the factorial plane (Figure 2C), indicating that both panels used these memories in a similar way for the evaluation of coffee samples.

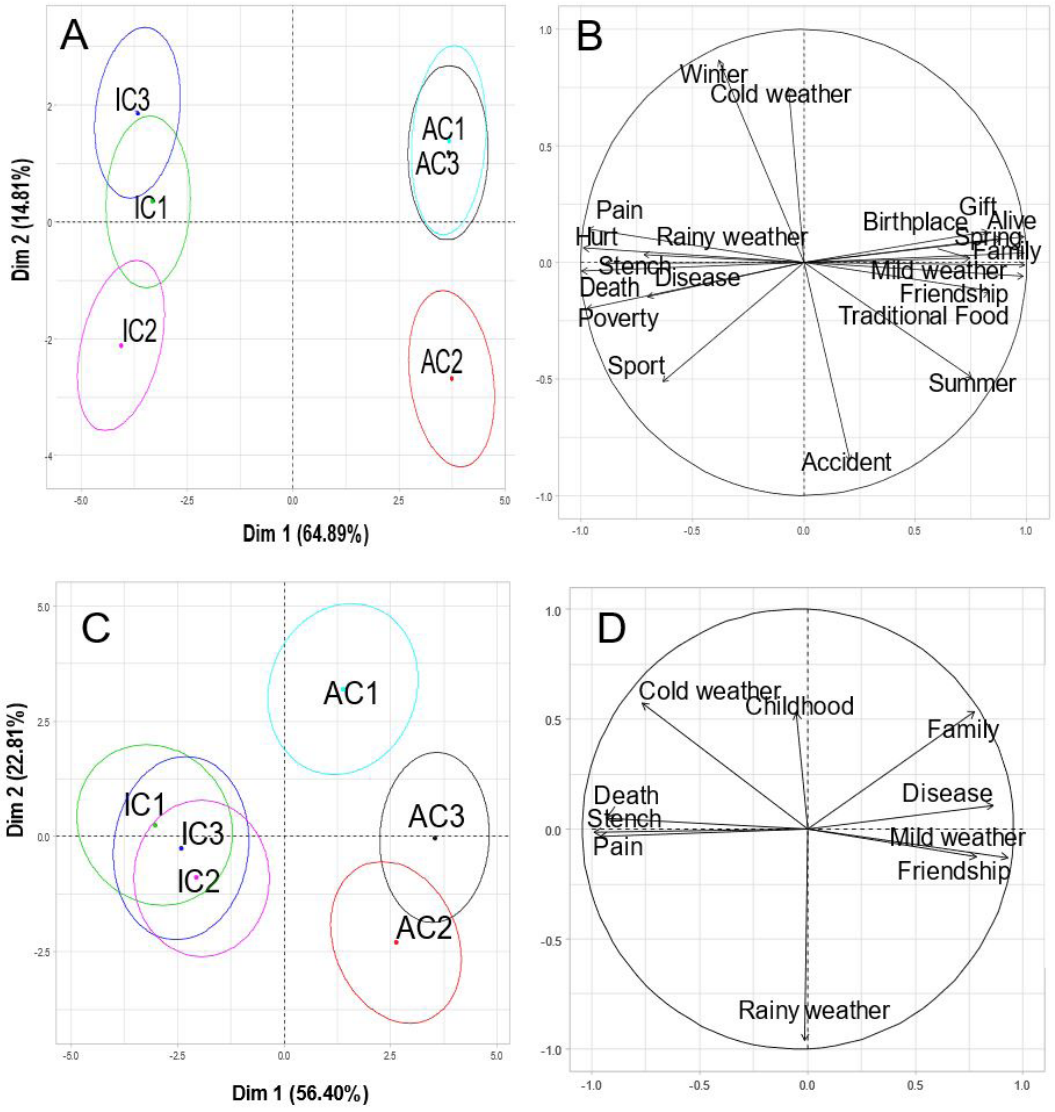

Figure 1. (A and B) Memories map and confidence ellipses with data from the trained panel; (C and D) Map of memories and confidence ellipses with data from the consumer panel. The maps were generated with the memories that had probabilities ≤ 0.05 of the Cochran's Q test. AC = Artisan coffee; IC = Industrial coffee.

Correlation of the coffee memories profile with other sensory data

Figure 3 shows the results of MFA for the correlation of the memories profile of coffees for each type of panel. Figures 3 A and B show that the memories profile is strongly correlated with the profiles of sensory attributes and emotions for each type of panel. For example, the trained panel obtained values of $Rv_{memories\text{-}attributes} = 0.95$, $Rv_{memories\text{-}emotions} = 0.94$ whereas the consumer panel obtained values of $Rv_{memories\text{-}attributes} = 0.84$, $Rv_{memories\text{-}emotions} = 0.76$. These values indicate that memories vocabulary can complement data on sensory attributes and emotions from a trained panel or a consumer panel. For example, according to results from both panels used in this research, the same discrimination was observed between artisanal and industrial coffee samples using the data from memories, emotions, and sensory attributes. (Figure 3C and D). After evaluating artisanal coffees, the trained panel experienced positive memories *Traditional Food, Friendship, Mild weather, Birthplace, Spring, Alive, Gift and Summer* as well as the negative memories *Accident* which could be generated by different sensory attributes *Acidic-T, Cinnamon-F, Citric-F, Cinnamon-A, Caramel-A, Chocolate-A, Chocolate-F, Fruity-F, Caramelized-F, Sweet-A, Sweet-T, Honey-F* and *Walnut-A* and that immediately evoked the emotions *Adventurous, Active, Good nature, Good, Calm, Happy, Enthusiastic, Free, Joyful, Secure, and Satisfies* (Figure 3C) Similarly, consumers experienced positive memories *Family, Friendship, Mild weather* and *Childhood* and the negative memories *Disease* could be generated by sensory attributes *Acidic-T, Fruity-F, Caramel-A, Caramelized-F, Citrus-F, Sweet-T, Sweet-A, Apple-F, Honey-F and Nut-F* and then they experienced the emotion *Pleasant.* For industrial coffees, the trained panel experienced different

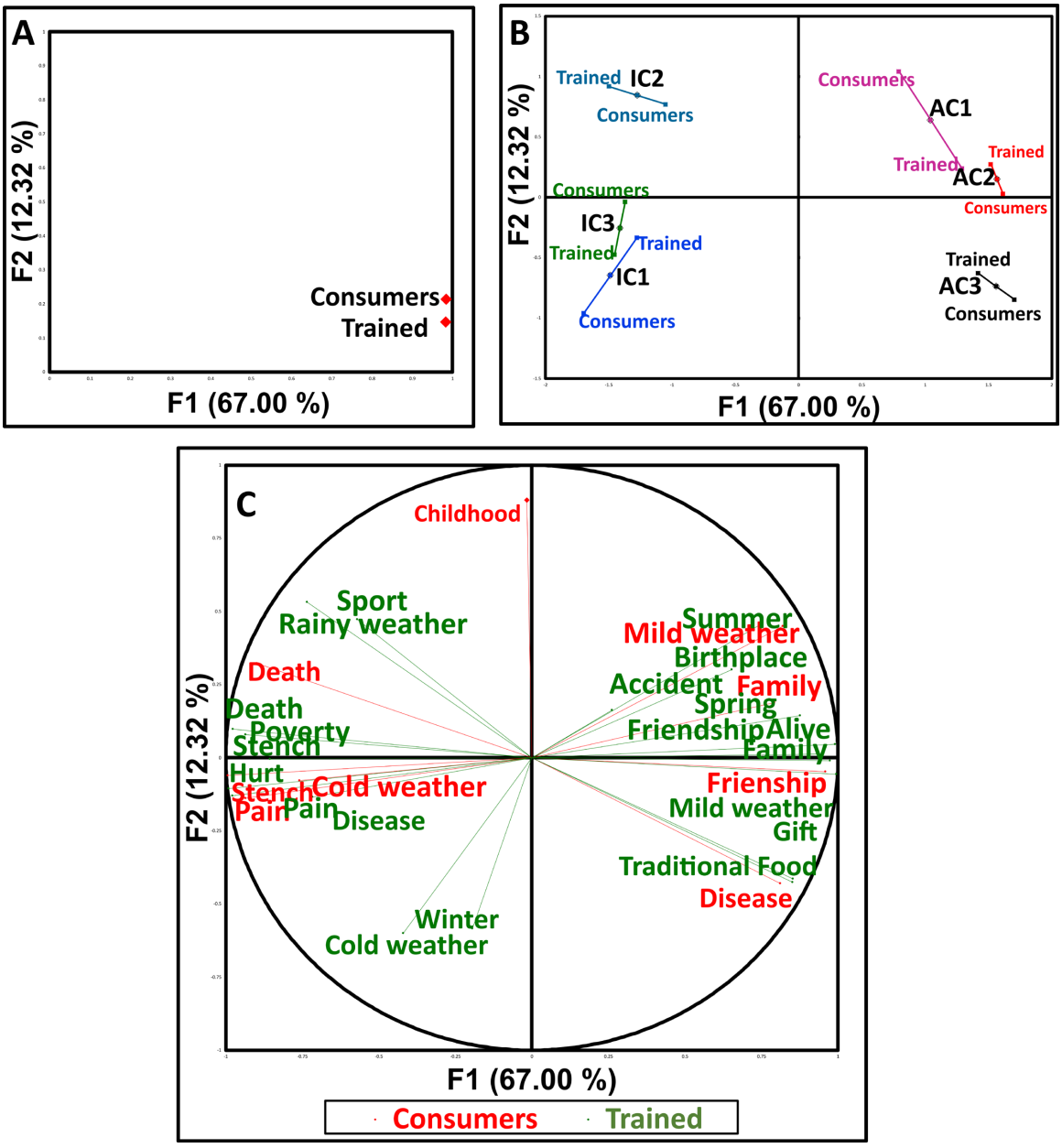

Figure 2. Multiple Factorial Analysis. (A) Representation of the panels; (B) Partial clouds; and (C) Memories used by the trained panel and the consumer panel. The maps were generated with the memories that had probabilities < 0.05 of the Cochran's Q test. AC = Artisan coffee; IC = Industrial coffee.

positive memories (*Rainy weather, Cold weather, Winter* and *Sport*) and different negative memories *(Hurt, Pain, Stench, Death, Poverty and Disease)* that could be generated by the sensory attributes *Bitter Chocolate-F, Coffee peel-A, Fermented-F, Smoke-F, Wood-A, Wood-F, Burnt-A, Burnt-F, Rancid-F, Earthy-A*, and *Spicy-A* and that later generated emotions *Bored, Aggressive, Disgusted, Nostalgic, Worried*, and *Wild* (Figure 3C). In this same sense, the consumer panel, after consuming the industrialized coffees, generated the positive memories *Cold weather* and negative memories *Pain, Stench* and *Death* that could be associated with the sensory attributes *Bitter-T, Chocolate-F, Smoke-F, Wood-A, Wood-F, Burnt-A, Burnt-F, Earth-F* and *Earthy-A* and that contributed to generate the emotions *Aggressive, Guilty, Disgusted and Wild* according to the proximity shown in Figure. 3D. In the case of negative memories *Accident* and *Disease* they may be mentioned because in Mexico, coffee is commonly served in sad situations such as funerals. On the other hand, the positive memories that industrialized coffees evoke were oriented toward the type of climate and sport. This result may be associated with the fact that people consider this type of coffees to be mostly consumed in places with cold and rainy climates while the *Sports* memories could be associated with people who use coffee as an energy drink (Tamamoto et al., 2010). Negative memories of industrialized coffees can be associated with the effect of seasonality on consumers. In

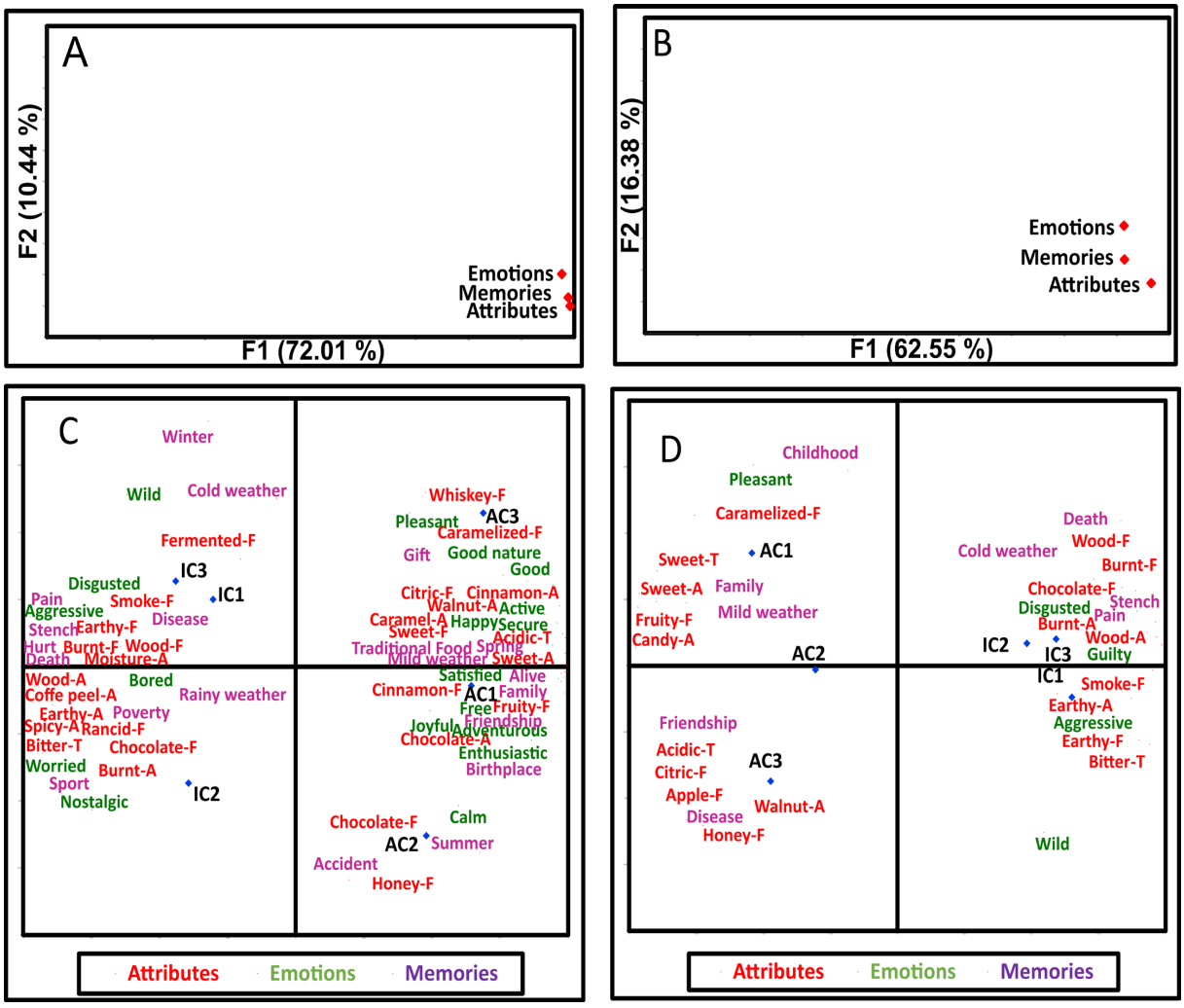

Figure 3. Multiple Factorial Analysis. (A) Representation of attributes, memories and emotions for the trained panel; (B) Representation of attributes, memories and emotions for the consumer panel; (C) Sensory characterization of coffees carried out by the trained panel; (D) Sensory characterization of coffees carried out by the consumer panel. The sensory maps were generated with the memories, sensory attributes and emotions that had probabilities < 0.05 of the Cochran's Q test. AC = Artisan coffee; IC = Industrial coffee; A = Aroma; F = Flavor; T = Taste.

this sense, there is scientific evidence that indicates that the time of year has an important effect on people and that it can generate different behavioral changes such as anxiety, depression, irritability, which have also been associated with a low economic level (Øyane et al., 2010). This justifies the negative memories *Poverty*. Negative memories *Hurt*, *Pain*, *Poverty* and *Disease* can be derived from the previous behavioral changes. Additionally, the negative memories *Death* could be cognitively associated with celebrations such as the "Day of the Dead" in Mexico (Brandes, 1998), where coffee is commonly consumed to accompany other foods, as well as at the funerals of a family member or friend. Positive and negative memories of industrialized coffees could have been evoked by different sensory attributes considered as negative such as spicy, rancidity, wood and earthy that after the mentioned memories evoked negative emotions (e.g., *Bored, Aggressive, Guilty, Disgusted, Nostalgic, Worried and Wild*). Both, emotions, and sensory attributes mentioned above were also reported in the studies of Bhumiratana et al. (2019) and Ramírez-Rivera et al. (2021) who evaluated coffee samples. Results from this study suggest that this first approximation of the memories vocabulary can be further evaluated with more emphasis in different situations such as 1) relationship of memories with preference data to explore in depth the possible memories that have the greatest influence on the purchase intent; 2) intra and inter-cultural studies to verify if the vocabulary of memories of this research is understood and used in the same way between different cultures; 3) to verify how the memories generated by the consumption of food at different times of the year can vary, since it has been shown that seasonality influences people's attitudes; 4) analysis of the duration of memories during consumption in real time using dynamic sensory techniques such as Temporal Dominance of Sensations; 5) the application of this memories vocabulary in other products where sensory evaluation has been used, such as cosmetics, medicines, automobiles, among others.

Likewise, this list of memories can be expanded or reduced according to the interests of the industry and researchers in the sensory field.

4 Conclusions

The proposed memories vocabulary has been generated from the sensory field and its validity and reliability is supported by the applied statistical treatment and the comparison with the memories terms published in the area of psychology. The memories vocabulary consisted of a total of 14 and 12 positive and negative memories terms, respectively. This number of memories were the most statistically representative based on the number of mentions and probabilities according to the textural analysis techniques (Factorial Approach for Sorting Task and Word-Count Based Methods Analysis). The memories vocabulary was used in a similar way by trained judges and consumers. The high correlations between sensory attributes (0.84-0.95) and emotions (0.76-0.94) with the memories (obtained using the memories vocabulary) indicated that the use of this vocabulary in conjunction with sensory attributes and emotions is a significant complement for the generation of a more robust food product characterization to achieve an improved connection between sensory science and marketing.

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