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A consumer-oriented model for analysing the suitability of food classification systems

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ABSTRACT

The main function of food classification systems is to regulate the market and inform it (consumers above all) about the different types of products and their characteristics. However, the reality is that many of these systems give rise to confusion and prevent consumers from obtaining a clear idea of them, making the purchasing process more difficult. The objective of this study was to propose a method that can be used as a basis or reference framework for analysing the suitability of any food classification system, based on maximising consumer comprehension and learning, before introducing it into the market. The model proposed establishes the procedure and the necessary indicators for identifying the advantages and drawbacks of each of the different systems, making it possible to compare their suitability. The model was tested empirically by comparing the current classification of orange juices and Iberian ham with two different proposals, in an experiment conducted with an online consumer panel, and using MANCOVA to analyse the differences between the six indicators related to consumer learning results. It was concluded that the model is suitable for assessing the suitability of the classification systems, as it shows technical viability, ease of introduction in practically any situation and the ability to facilitate and guide the process of drawing up consumer-oriented food classification systems.

1. Introduction: the food classification problem

To help consumers to choose among the wide range of different foods available on the market and regulate their marketing, a number of food classification systems (FCS) have been drawn up. They are composed of a set of categories accompanied by descriptions that provide information on their respective characteristics. However, the reality is that in many cases consumers are incapable of making suitable choices and display a low level of product knowledge. This problem can be attributed not only to changes in FCSs, but also to the deficiencies or limitations of the systems themselves. Rather than helping or facilitating the process of choosing and buying, problems such as the use of similar terms, ambiguous descriptions of the products included in each category or confusing or excessively technical descriptors included in labels can sometimes confuse consumers and lead to erroneous beliefs (Aydinoglu and Krishna, 2011; Dörnyei and Gyulavári, 2015; Dunbar, 2010; Garg et al., 2007; Grunert et al., 2010; Grunert and Wills, 2007; Hall and Osses, 2013; Mackey and Metz, 2009; Mackison et al., 2008; Malam et al., 2009; Nocella and Kennedy, 2012; Sharf et al., 2012).

The term FCS has been employed in the literature to indicate the empirical manner in which consumers classify food products in their day-to-day lives (snacks full meals, homemade or precooked food, consumption occasion, etc.) or proposals or documents of a technical nature relating to nutrition, marketing and international harmonisation (for further details see part 2). Food classifications are relevant with regard to organisation and communicating information within different areas of food science, such as nutrition, marketing, unit operations and microbiology (Costa et al., 2001). In our context we consider FCSs to be restricted to official food classifications, of compulsory establishment on the Market in order to provide information to consumers and to all the elements of the agrifood chain, homogenising and harmonising production and marketing, varieties and/or qualities. They are usually designed with technical committees proposals, which consults experts or members of the sectors affected.[1] As a consequence, there can occurs a gap between the theoretical objective of the sys-

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[1] In the European scope, the European Commission drafts reports modifying or changing classifications which may finally be discarded when the final Regulations are approved (for an example of the case of olive oils, see: on the proposal for a Council regulation amending Regulations No 136/66/EEC and (EC) No 1638/98 as regards the extension of the period of validity of the aid scheme and the quality strategy for olive oil (COM(2000) 855 – C5-0026/2001 – 2000/0358(CNS))).

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tem (to inform, clarify, help with the choice, eliminate confusion, enhance nutrition, etc.) and how these classifications are really interpreted by the consumers.

In essence, in the present study, an FCS is made up of two parts: a set of terms (categories) and descriptions of each category (information). Naturally, since the aim is to produce a guide for consumer orientation and clarification and the categories and descriptions are necessarily limited in length, the choice of terms and wording is crucial. The choice of one word or another can influence the marketing of the product and the structure of the market for years, and can make consumer learning much more easy or difficult. In the same way, it can favour certain categories or levels of quality over others. Finally, the connotations of words must not be forgotten, as they have a heuristic potential for generating possibly false beliefs in the mind of the consumer (Smith et al., 2013, 2014).

Despite the negative repercussions that a poor categorisation system can have (a clear example is given in Section 1.1), the bibliography does not mention any model that can serve as a guide to assessing the suitability of a system, leading to inefficiencies in system design processes and serious problems on the market.

The fundamental objective of this research is to develop a model or method for analysing the suitability of an FCS from the point of view of its main function when used in a food education context: to inform and help consumers in making choices. The starting point, therefore, is that the suitability of any system proposed depends on its usefulness to consumers in deciding purchases and on how easy it is to learn and how easily and effortlessly it differentiates between the different products and their characteristics.

1.1. A typical case of the problems caused by a poor classification system: olive oils

A prime example of how poor categorisation can cause confusion among consumers and influence product marketing for many years is what has happened with olive oils in Spain. The current classification of olive oils is the result of a series of EU regulations that have successively tried to remedy the deficiencies of some agents detected in previous classifications. Table 1 summarises the current classification of olive oils and the problems it has been found to cause.

All these problems that spring from the quality of the official classification may have effects on consumer learning and confusion. In the case of Spain, for instance, the top world olive oil producer and a country where this is one of the most emblematic products in the diet, over 60% of consumers think that "olive oil is pure olive juice, without manipulation"(related to problem 2), only 30% know that "olive oil is a mixture of virgin and refined olive oils" (related to problem 2 and 6) and over 70% think that "the main factor in differentiating between qualities is the acidity" (Torres-Ruiz et al., 2015). This could explain that the most consumed oil in Spain is olive oil (not virgin), in spite of its lower quality and healthiness[2] and even though the difference in price is barely € 0.3/litre according to the Ministry of Agriculture, Food and Environment food consumption panel data (2015). Furthermore, many producers find it difficult to sell quality oils. In short, the official classification system is no incentive to quality, production levels or consumption, in opposition to the guidelines of the Common Agricultural Policy and the efforts of the Spanish Government.

However, olive oil is not an isolated case. The problem of using terms that are both attractive and similar for clearly different products, hindering consumer learning and choice, is also found to persist in other cases such as the Spanish cases of fruit juices (Royal Decree 781/2013) (fruit juices, fruit juices from concentrate, concentrated fruit juices, dehydrated or powdered fruit juices and fruit nectar) and Iberian ham (100% Iberian acorn-fed ham, Iberian acorn-fed ham, Iberian pastured, fodder-fed ham ('de cebo de campo') and Iberian fodder-fed ham ('de cebo')). Furthermore, this classification of hams in Spain is the result of a recent change in the nomenclature, as the former designations were understood to cause confusion and misunderstandings (Royal Decree 4/2014). Both classifications are analysed empirically in this work.

The problem is important and shows the need for a model or method that will allow *a priori* assessment of the effectiveness of a classification system based on objective indicators.

2. Types of food classification systems from the point of view of consumer participation in the design

Many groups of people are interested in food categorisation systems (dieticians, teachers, cooks, retailers, producers, government agencies, etc.) and in their international harmonisation or coordination, which is necessary to facilitate trade between countries. As a result, attention has been paid to these systems, although frequently from a different perspective from that of the present research (usefulness to consumers from the perspective of marketing and food policy). From the point of view of consumer participation or consultation, the bibliography containing the referenced term can be divided into two groups.

2.1. Technical or technological classification systems

Systems based on technical aspects of foods, such as their characteristics and nutritional description, generally aim to be general reference works covering all foods. Their basic usefulness is as references for researchers, government agencies and international trade. The most common technical classification systems are based on nutrition and diet (Costa et al., 2001). Typical examples are the fruit and vegetable system devised by Pennington and Fisher (2009), or that of Lennernäs and Andersson (1999), based on eating episodes (Food-Based Classification of Eating Episodes-FBCE).

Computerised systems which classify foods into universal categories or enter foods and their descriptions into large databases (Ireland and Møller, 2000) can be included among the technical or technological classification systems. Classifications are based on different criteria, such as type (vegetable, cereal, etc.) or use (drink, main meal, etc.). In turn, the categories can be divided into subcategories with more precise descriptions. Some International databases can be included in this group. One of these is *Eurocode 2*, a European system based on alphanumerical codes, which highlights food products' features of interest for people conducting surveys (Leclercq et al., 2001). Another important system involves *Langual*, a multilingual facetted thesaurus created to describe foods in a systematic manner, and whose main objective is to develop a common classification system in Europe (Ireland and Møller, 2010). Recently, it has been developed the food classification and description system FoodEx2 by the European Food Safety Authority (2015). This is a FCS with a great capacity to collect descriptive elements and organise the group of foods hierarchically.

In general, these systems are not intended for end consumers. They also present some problems, such as that the same product can be classified into two or more groups, that the generic descriptions of the foods can sometimes be very vague and give little detail, or that because of differences in legislation, economic importance and culture, they vary in each country (Ireland and Møller, 2000). As Costa et al. (2001) pointed out, they are incapable

[2] At least when it is consumed at low temperature (considering its antioxidant content), since when it is subjected to high temperatures there is no consensus in the literature (Santos et al., 2013).

Table 1
Current classification of olive oils* (only those sold directly to the end consumer) and problems.

Generic term: olive oils (problem 1), comprising three categories (problem 2): 1. Extra-virgin olive oil: superior category olive oil obtained directly from olives and solely by mechanical means 2. Virgin olive oil: olive oil obtained directly from olives and solely by mechanical means 3. Olive oil–composed exclusively of refined (problem 3) and virgin olive oils[a] (problem 4): oil comprising exclusively olive oils that have undergone refining and oils obtained directly from olives
Additional information: To classify oil as extra-virgin or virgin, physical and chemical criteria are employed (which may be mentioned on the label). They include the degree of acidity (problem 5), the peroxide value and the ultraviolet absorbency. The organoleptic quality is also assessed. Fewer indicators are employed to categorise olive oil (problem 2) and the sensory characteristics are not assessed, as this is a different product
Problem 1: the generic term for olive oils and that of the third category, the one of least quality, are practically the same (only distinguished by the final s). As a result, generic promotions actually promote the least healthy and lowest quality oil, which is what happens with the promotion efforts of the olive oil sector Interprofessional organisation. This is contrary to the CAP quality policy and to the sector's quality improvement efforts
Problem 2: the generic term includes two very similar products (extra-virgin and virgin olive oils) which are 100% natural juices, and one very different product (olive oil) that only contains a small quantity of natural juice. Including them in the same category instead of separating them leads to the three types of oil being perceived as similar, so many consumers think that olive oil is also a natural juice.
Problem 3: terms that evoke *positive* characteristics are used. The term 'refined' has connotations of purity and greater quality. In the context of oils, it means taking oils with defects, not fit for human consumption, and removing every trace of odour and flavour by means of physical and chemical processing. A small proportion of virgin olive oil then has to be mixed into give it some flavour. Although it is the lowest quality oil, the connotations of the word 'refined' suggest to some consumers that it is the oil of highest quality
Problem 4: te name of the third category is too long (olive oil – composed exclusively of refined and virgin olive oils), so consumers end up using only the abbreviated name 'olive oil'
Problem 5: terms that evoke *negative* characteristics are used, leading consumers to develop false beliefs. The term 'acidity' has connotations of strong flavour. In the context of olive oils it refers to the quantity of free fatty acids, in terms of oleic acid, and is unrelated to flavour
Problem 6: similar terms or the same names are used, adding further names for each category, instead of quite distinct terms for each. Having to learn more names makes learning more difficult
*As set out in article 3 (a), (b) and (c) of Commission Implementing Regulation (EU) No 29/2012 of 13 January 2012 on marketing standards for olive oil. Source: Own compilation based on Cabrera et al. (2015), Marano-Marcolini and López-Zafra (2009), Marano-Marcolini et al. (2015), Navarro et al. (2010), Parras (2000), Parras and Torres (1996), Torres et al. (2012, 2015)

[a] For obvious reasons, in this work this category will now be called with the shortened name of olive oil (problem 4).

of striking the necessary balance between detail and comprehension and are rarely tested to check their classificatory capability.

2.2. Systems or modifications based on consumer studies/market experience

Outside the technological sphere, writings on FCSs that cover generic descriptions of products are not very abundant and focus on brand names or words used to describe certain properties of the foods (Smith et al., 2010). These studies are usually restricted to a single type of category or food and are based on consumer studies, essentially garnering opinions and perceptions of current systems or what the products suggest or evoke. As a result of the findings, recommendations are given on how certain foods should be categorised because this will influence how they are marketed. Some examples of this type are the classification by Wadhera and Capaldi (2012), who distinguish between 'snack' and 'meal'; the studies by Hoek et al. (2011) on meat and meat substitutes; Marano-Marcolini et al. (2015) on olive oils; Smith et al. (2010, 2013, 2014), based on sensory properties; Blake et al. (2007) and Furst et al. (2000), based on consumption experience or the way in which consumers classify foods empirically in their daily life; and Costa et al. (2001) classification of 'home meal replacements' (HMR).

In short, these studies relating to both systems are highly heterogeneous, owing to their different underlying assumptions, methods and types of product analysed, and they have clearly different objectives: dietary information and harmonisation in the first case, and understanding how consumers categorise and interpret food in the second. However, in the first case a link is missing between the technical information and the usefulness provided to the consumer and in the second case, there is a need for specific conclusions to help to orient the Administration in the decision-making process referring to FCS. Regarding these two systems, we highlight the need to develop FCS constituting clear (and useful) reference frameworks for producers, politicians and, above all, consumers. Nonetheless, nowhere in the literature can one find a clear definition of how a good FCS should be or how to develop it within this context.

3. Basic characteristics and principles of an FCS: a proposal

The basic function of an FCS is as a reference for the purchasing process, enabling consumers to choose the product they want in full awareness of that product's characteristics and differences compared to other products. This system needs a set of categories or descriptors (symbolic or alphanumerical terms used to identify products quickly) and a block of information associated with each descriptor that makes it possible to acquire clear and specific knowledge of the characteristics of the products associated with each category (Costa et al., 2001; Lennernäs and Andersson, 1999).

From this point of view, one system will be better than another if the consumers have a greater knowledge of its categories and of the information associated with them. However, which aspects or dimensions should be taken into account when studying the level of knowledge of a system? Considering that its purpose is to make purchasing easier, the information (knowledge) that consumers find necessary and useful will be:

1. The existence of different categories/types of foods and their names or labels. Naturally, this implies knowing that different types exist.
2. Knowing or ranking the categories according to their quality.
3. Knowing the basic and main characteristics of each category, particularly those related to purchasing decisions (best uses, chemical composition, nutritional properties, etc.).

The first two conditions constitute the basic or minimum information for making efficient choices.

How much the consumers know decides the suitability of any system and constitutes the basic dimension for comparing competing classification systems. Given the basic purpose of the system (for reference), one system will be better than another according to how much consumers know about it: this is a problem of learning and of processing and retrieving information from memory (explicit memories). There are different ways of assessing the information retrieval or measuring memory. The measures can be explicit or implicit. The former analyse explicit memories, which are those that people have consciously, and the latter measure unconscious memories, which are those that cannot be retrieved consciously (Anderson, 1995). Given the nature of the FCS, this work focuses on explicit memories. Among the most commonly used explicit measures are the tasks of recalling and recognition, widely employed in the field of Psychology (Anderson, 1995).

The difference between recalling and recognition is that the first one is the process in which the person retrieves previously learnt information from memory without clues or aids. By contrast, the recognition is the process in which the person retrieves information with the aid of material showed during the test. This is the reason why in recalling the participant should remember a stimulus which is not present, while in recognition, the information that allows to discriminate against one and other is given (Bettman, 1979). In the literature there are several models or systems which compare recalling and recognition like the dual-process model (Anderson and Bower, 1974; Kintsch, 1974), the modified dual-process model, the encoding specificity principle (Tulving and Thomson, 1971; Tulving and Watkins, 1973; Tulving, 1976) or the models of search of associate memory (Search of Associative Memory-SAM) (Gillund and Shiffrin, 1984). In general, it is assumed that the study of both dimensions enriches the measures of information retrieval from memory so they have been widely used in contexts of consumption and marketing (Ahn and La Ferle, 2008; Bagozzi and Silk, 1983; Dubow, 1995; Hartmann et al., 2013; Hutchinson et al., 1994; Jin et al., 2008; Krishnan and Chakravarti, 1993; Leigh et al., 2006; Lerman and Garbarino, 2002; Lowrey et al., 2003; Norris and Colman, 1992; Singh and Rothschild, 1983; Zinkhan et al., 1986).

In addition, the mental retrieval of information by consumers is prior to actions involving the recall or recognition of that information. It is easy to consider real situations related to consumer behaviour. For instance, mental retrieval of information memorised by the consumer precedes actions such as, for example, requesting a product in a shop, or a conversation between two consumers in which one recommends a product to the other and conveys information about its characteristics, or a situation in which a consumer is considering cooking a dish and 'remembers' that it will require buying a type of product with certain characteristics. In the same way, a self-service purchase is a clear example of recognition activity: consumers are faced with a large quantity of products on the shelves and recognise the type of product they are looking for by its label.

4. Proposed model for analysing the suitability of FCSs

The model was designed in accordance with the basic theoretical principles concerning the memory and information retrieval processes discussed in Section 2.2 above. In the present context, this includes the recall and recognition tasks that lead to retrieval

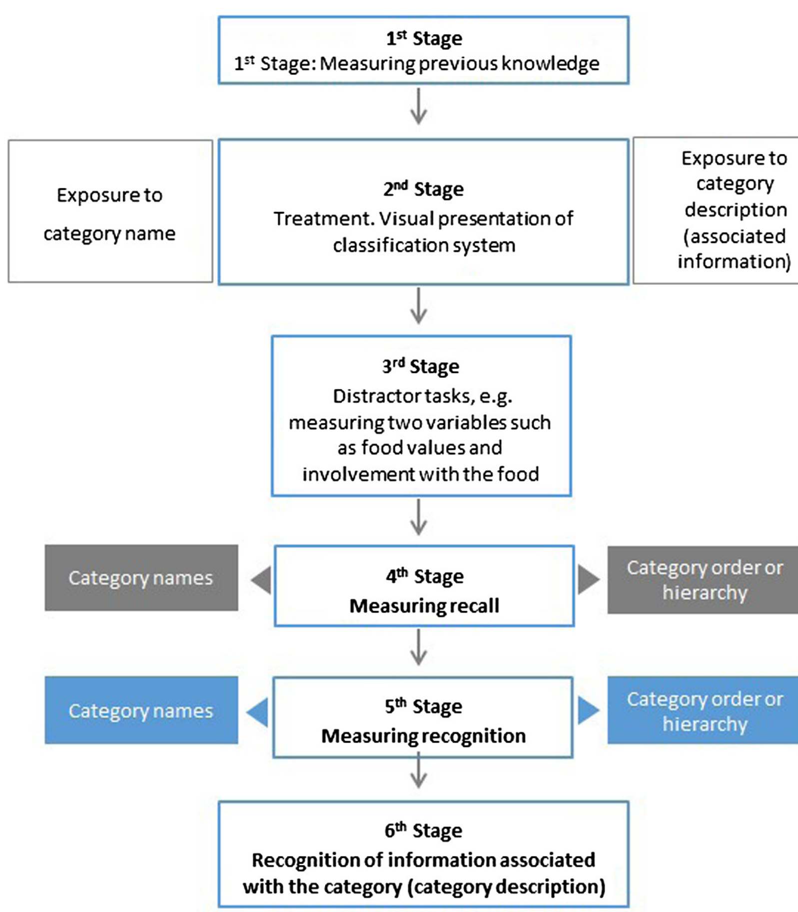


Fig. 1. FCS analysis model.

of the information stored in the memory, the activities that need to be performed in order to be efficient in a consumption choice situation, and a sequential process that describes the tasks to be performed, divided into six stages (Fig. 1).

The first stage is to measure prior knowledge about the product, as this influences the learning and processing of new information (Alba and Hutchinson, 1987; Ofir et al., 2008; Rao and Monroe, 1988; Smith et al., 2015; Wood and Lynch, 2002; Zinkhan et al., 1986) and the consumers' assessment of the product (Hong and Sternthal, 2010). This measurement is particularly important if one of the categories to be used or compared is the current one, as some consumers will be more familiar with it than others and this will influence their recall and recognition of the categories (Johnson and Russo, 1984; Lynch and Srull, 1982). From the operative point of view, it can be done by generating a series of phrases, some correct and others not, and measuring the subjects' knowledge on a simple scale (true - false - don't know/no answer). Their knowledge is measured as the number of right and wrong answers.

The next stage is to show clues to the participants. In the literature on memory, this is made showing a number of words or images for a few seconds to measure the number of them that can be recalled without mistakes (Ahn and La Ferle, 2008; Anderson and Bower, 1974; Bagozzi and Silk, 1983; Dubow, 1995; Gillund and Shiffrin, 1984; Hartmann et al., 2013; Hutchinson et al., 1994; Jin et al., 2008; Krishnan and Chakravarti, 1993; Leigh et al., 2006; Lerman and Garbarino, 2002; Lowrey et al., 2003; Norris and Colman, 1992; Singh and Rothschild, 1983; Tulving, 1976; Zinkhan et al., 1986).

In the present model, during stage 2 each subject is shown one of the classification systems being assessed, for a limited time. The system comprises certain terms or categories and the descriptive information associated with each category (characteristics, ingredients, preparation method, level of quality, etc.).

The third stage involves a series of distractor tasks that could interfere with retaining information in the memory and could attenuate passive and repetitive thinking (Harris and Pashler, 2005; León et al., 2010; Papageorgiou and Siegle, 2003). The basic idea is that some time should pass between exposure to the stimulus and examination of what has been learnt.

Stages four and five focus on measuring recall and recognition of the categories or descriptors of the system being examined. In stage 4 the subjects are asked to write down the categories they remember spontaneously, with no stimulus to facilitate the task, and order or rank the categories according to their quality. In stage 5, the subjects must recognise the categories they were shown previously and their order, selecting them from a sufficiently long list. In both stages the number of right and wrong answers is counted for both the choice of words and their order.

Stage 6 centres on examining how much of the information or description accompanying the term designating the food has been recognised. To do this, the information is divided up into significant fragments or blocks of information (with content) and shown to the consumer in a sufficiently long list (e.g. mixing up all the blocks). As in the previous stage, the right and wrong answers are used as indicators.

Naturally, the variables for comparing and deciding which system is best are the indicators related to knowledge (right and wrong answers), depending on each case. Effective comparison between systems with different numbers of categories requires homogenising the indicators. This can be done by working with percentages (% of correct answers) instead of absolute frequencies (number of right answers), for instance.

Table 2
Information presented to each experimental group on the computer screen (orange juice).

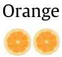
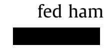
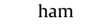
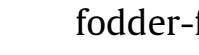
Category	Category description
Treatment B (n = 120)	
Orange juice 	100% juice of fresh oranges which are sound and ripe, preserved through chilling or freezing, having the characteristic colour, flavour and taste of the juice of this fruit. No added sugars
Orange juice 	Product obtained exclusively from orange juice that has previously been dehydrated and subsequently reconstituted with drinking water. Flavour, pulp and cells of oranges are added. No added sugars
Orange juice 	Product obtained by adding water, sugars and other additions to orange puree, with a minimum orange content of 50%
Treatment A (n = 120) (currently in force)	
Orange juice	The fermentable but unfermented product obtained from the edible parts of fruit which is sound and ripe, fresh or preserved by chilling or freezing, of one or more kinds mixed together, having the characteristic colour, flavour and taste typical of the juice of the fruit from which it comes
Orange juice made from concentrate	The product obtained from the juice of one or more species of fruit through physical extraction of a certain part of the water and subsequent reconstitution with drinking water. Flavour, pulp and cells obtained by suitable physical means from the same kind of fruit may be restored to the concentrated fruit juice
Orange nectar	The fermentable but unfermented product obtained by adding water, with or without the addition of sugars and/or honey to the fruit puree and/or concentrated fruit puree and/or a mixture of these products. Minimum orange content 50%. The flavour, pulp and cells obtained by suitable physical means from the same species of fruit may be restored to the fruit nectar

Table 3
Information presented to each experimental group on the computer screen (Iberian ham).

Category	Category description
Treatment D (n = 120)	
100% Iberian acorn-fed ham 	Ham from pigs which are 100% pure-bred Iberian pigs intended for slaughter immediately after feeding exclusively on acorns, grass and other natural resources of the *dehesa* (holm oak forest) without any supplementary feed
Acorn-fed ham with a minimum of 50% Iberian blood 	Ham from pigs with at least 50% Iberian blood intended for slaughter immediately after feeding exclusively on acorns, grass and other natural resources of the *dehesa* without any supplementary feed
Fodder-fed ham with a minimum of 50% Iberian blood	Ham from pigs with at least 50% Iberian blood which are reared through a diet of fodder, mainly cereals and legumes, and whose management is carried out in intensive pig-rearing systems
Treatment C (n = 120) (currently in force)	
100% Iberian acorn-fed ham 	Ham from pigs which are 100% pure-bred Iberian pigs intended for slaughter immediately after feeding exclusively on acorns, grass and other natural resources of the *dehesa* without any supplementary feed
Iberian acorn-fed ham 	Ham from pigs with at least 50% Iberian blood intended for slaughter immediately after feeding exclusively on acorns, grass and other natural resources of the *dehesa* without any supplementary feed
Iberian pastured, fodder-fed ham 	Ham from pigs with at least 50% Iberian blood that, although they have reached a certain weight through mast feeding, have been reared through a diet of fodder, mainly cereals and legumes, and whose management was carried out in free-range or intensive pig-rearing systems, even part of the rearing area can be covered

5. Application of the model: comparison between two classifications of orange juices and two of Iberian hams

In order to test the viability of the model, three categories of the current classifications of orange juices and Iberian hams in Spain (A,C) were compared with a different proposal (B,D), respectively (Tables 2 and 3). The objective was to examine the model's ease of application, possibilities for providing useful information and sensitivity in detecting differences in quality between different classifications. The proposed classification (B) uses images (oranges) instead of similar terms to distinguish between the categories (and quality levels) according to the number of images in order to avoid the excellence connotations and potential confusion due to terms used in the current FCS (A). Similarly, for Iberian ham, the proposed system (D) uses acorn images instead of colours (C) because acorns are more intuitive than colours as they do not evoke hierarchy of quality. Acorns refer to the pigs' diet. Thus, the more acorns appear, the higher quality the product will be. In general, using images is more intuitive and similar reference frameworks already exist (e.g. the star system for hotels), it was thought that it might make learning easier for the consumer. Signals like images, colours or logos are widely used in the literature on food labelling due to their heuristic function of product attributes (Andrews et al., 2011; Ares et al., 2011, 2012; Becker et al., 2015; Borgmeier and Westenhoefer, 2009; Cowburn and Stockley, 2005; Emrich et al., 2012; Feldman et al., 2013; Feunekes et al., 2008; Hawley et al., 2013; Méjean et al., 2013; Sharf et al., 2012; Siegrist et al., 2015; Smith et al., 2015; Van Herpen and Van Trijp, 2011; Vasiljevic et al., 2015). All of these is based on the assumption that the information overload in labels (Bialkova et al., 2013; Burton et al., 1994; Dunbar, 2010; Hall and Osses, 2013; Levy et al., 1996; Park et al., 1989), the short time available for purchasing (Caswell and Padberg, 1992; Loebnitz et al., 2015; Reutskaja et al., 2011; Wandel, 1997) and the lack of consumers' implication and knowledge (Hamlin, 2010; Scheibehenne et al., 2007) (in relation to other types of products)

Table 4
Stages measuring recall, recognition and the information learnt about each category (orange juice).

Recall (stage 4)
Of the types of orange juice we have presented to you, which do you remember? If there were any symbols or images please state what they were
______ ______ ______
Which of these was of the highest quality?
______ ○ I don't remember any
And which was of the second-highest quality?
______ ○ I don't remember any
And the third?
______ ○ I don't remember any
Recognition (stage 5)
We will now show you a list of orange juice categories. Of the categories you remember (maximum three), please click on the one you think is of the highest quality, then on the second-highest quality and lastly on the third quality.

(continued on next page)

Table 4 (*continued*)

Orange juice	100% natural orange juice
Orange juice	Orange juice reconstituted with additions
Orange juice reconstituted with additions	100% natural orange juice
Orange juice class 2	100% natural rehydrated orange juice
Orange nectar	Orange juice
Orange juice	100% natural rehydrated orange juice
Orange juice	Orange juice
100% natural rehydrated orange juice	Orange juice reconstituted with additions class 3
Orange juice class 1	100% natural orange juice class 1
100% natural orange juice	Orange juice made from concentrate
Orange juice	Orange juice class 3
100% natural rehydrated orange juice class 2	Orange juice reconstituted with additions

Associated information (stage 6)

involve the use of simple FCSs and visual symbols. For orange juices, categories with the same name but with different numbers of images were used. In the case of ham, the terms were different because the breed is of crucial importance for the quality and reference to quality was made in the categories. Finally, the number of images (3, 2, 1) in the case of orange juices differs from the case of ham (2, 1, 0) in the proposed systems. The reason for that was that the ham of the third category is not from acorn-fed pigs but from fodder-fed pigs so it can confuse customers.

The sample comprised 480 consumers in an online panel recruited by a market research company, selected from 18 Spanish cities which do not belong to producing areas. They were divided randomly into four experimental groups with a similar distribution by educational level, age and gender. The experiment was performed in December 2014. Their prior knowledge about juices and ham was measured through a battery of 11 items of the true-false-don't know type –see Appendix A-, after which each group viewed one system on the screen for one minute (Tables 2 and 3).

Following a series of distractor tasks (a series of questions to measure psychographic variables), the information for stages 4, 5 and 6 was shown on a sequence of screens (Table 4), in the case

Table 4 (*continued*)

For the categories of juices shown below, please put an X against the information you remember having seen for each one. Bear in mind that there may be several correct statements (more than one statement associated with the category) and statements that are repeated for more than one type of juice.	
Orange juice 	○ Having the characteristic colour, flavour and taste of this fruit ○ Minimum orange content 50% ○ No added sugars ○ Preserved by chilling or freezing ○ 100% juice of ripe fresh oranges ○ Obtained by adding water, sugar and other additions to orange puree ○ Flavour, pulp and cells of oranges are added ○ Obtained exclusively from orange juice that has previously been dehydrated and subsequently reconstituted with drinking water
Orange juice 	○ Preserved by chilling or freezing ○ Obtained exclusively from orange juice that has previously been dehydrated and subsequently reconstituted with drinking water ○ Minimum orange content 50% ○ Flavour, pulp and cells of oranges are added ○ 100% juice of ripe fresh oranges ○ Obtained by adding water, sugar and other additions to orange puree ○ No added sugars ○ Having the characteristic colour, flavour and taste of this fruit
Orange juice 	○ No added sugars ○ Preserved by chilling or freezing ○ Having the characteristic colour, flavour and taste of this fruit ○ Flavour, pulp and cells of oranges are added ○ Obtained exclusively from orange juice that has previously been dehydrated and subsequently reconstituted with drinking water ○ Obtained by adding water, sugar and other additions to orange puree ○ 100% juice of ripe fresh oranges ○ Minimum orange content 50%.

of orange juices with the treatment B. In stage 6, the descriptions were divided into independent sentences with autonomous information content, extracted from the category descriptions, and the panellists had to choose the information that belonged to each category. The process for treatment A (current classification) was the same, only changing the categories and sentences used in stage 6, based on information shown in Table 2. Similar considerations could be applied to C and D (Iberian ham case).

The variables measured in the recall test were the number of right answers when remembering the category names (Y_1) and stating their order of quality (Y_2). During the recognition stage, the variables quantified were the number of right answers when selecting the correct replies from those which appeared on the screen (Y_3) and ordering them by quality (Y_4). In all four cases the values ranged from 0 (no category recalled) to 3 (all categories recalled). During the associated information stage, the number of right answers associated with each category was measured as an indicator of effective learning (Y_5) and the number of wrong answers as an indicator of confusion (Y_6). In both cases the variables ranged between 0 and 8. The six variables measured different aspects and can be used as clear indicators for comparing the suitability of different elements of the four systems of categories.

Finally, it should be mentioned that throughout the succession of stages and presentations, the panellists could not turn back to

Table 5
Mancova. Global differences between two orange juice FCSs (current system versus proposed system).

Effect		Value	F	Hypothesis df	Error df	Sig.
Classification type (A, B)	Pillai's trace	0.246	12.451	6.000	229.000	0.000
	Wilks' lambda	0.754	12.451	6.000	229.000	0.000
	Hotelling's trace	0.326	12.451	6.000	229.000	0.000
	Roy's largest root	0.326	12.451	6.000	229.000	0.000
Co-variable (prior knowledge)	Pillai's trace	0.066	2.705	6.000	229.000	0.015
	Wilks' lambda	0.934	2.705	6.000	229.000	0.015
	Hotelling's trace	0.071	2.705	6.000	229.000	0.015
	Roy's largest root	0.071	2.705	6.000	229.000	0.015

A = current system; B = proposed system.

Table 6
Ancova. Differences between two orange juice FCSs (current system versus proposed system) in each of the six indicators.

Source	Dependent Variable	Type III sum of squares	df	Mean square	F	Sig.
Classification type (A, B)	Recall (Y_1)	7.383	1	7.383	5.051	0.026
	Recall of order (Y_2)	4.648	1	4.648	2.907	0.090
	Recognition (Y_3)	11.446	1	11.446	11.676	0.001
	Recognition of order (Y_4)	8.171	1	8.171	8.913	0.003
	Information – right answers (Y_5)	71.643	1	71.643	21.681	0.000
	Information – wrong answers (Y_6)	22.283	1	22.283	7.104	0.008
Co-variable (prior knowledge)	Recall (Y_1)	3.786	1	3.786	2.590	0.109
	Recall of order (Y_2)	1.293	1	1.293	0.809	0.369
	Recognition (Y_3)	3.023	1	3.023	3.084	0.080
	Recognition of order (Y_4)	1.982	1	1.982	2.162	0.143
	Information – right answers (Y_5)	28.667	1	28.667	8.675	0.004
	Information – wrong answers (Y_6)	16.359	1	16.359	5.216	0.023

A = current system; B = proposed system

Table 7
Differences of means between the two systems (only significant differences).

Dependent variable	A-B	Mean	Std. error	95% confidence interval	
				Lower limit	Upper limit
Recall (Y_1)	A	1.233	0.110	1.016	1.451
	B	0.880	0.112	0.660	1.101
Recognition (Y3)	A	0.808	0.090	0.630	0.986
	B	1.248	0.092	1.068	1.428
Recognition of order (Y4)	A	0.483	0.087	0.311	0.656
	B	0.855	0.089	0.680	1.029
Information – right answers (Y5)	A	2.558	0.166	2.231	2.885
	B	3.658	0.168	3.327	3.989
Information – wrong answers (Y6)	A	2.750	0.162	2.432	3.069
	B	2.137	0.164	1.814	2.459

A = current system; B = proposed system.

previous screens. This is important in that the model is designed to bring in additional information sequentially. In other words, the sequence of steps in the model is designed to ensure that information given on the screen in order to perform certain measurements cannot influence later measurements.

6. Results and discussion

To discover which FCS is better, two MANCOVAs were performed with the six measurements as the dependent variables, while the independent variables were the treatment type (A or B) or (C or D) in each one and prior knowledge, acting as a co-variable**.** It is measured as the number of right answers (R) minus the number of wrong answers (W) or *don't knows* (I), resulting in a variable (R-W-I) with a range of −11 to 11, given that eleven was the number of items.

6.1. Orange juice model

Firstly, the homogeneity of slopes (or parallelism) hypothesis was examined by introducing the interaction between treatment and covariable into the model. Once the hypothesis had been accepted, the model was recalculated, eliminating this interaction[3] (Table 5). The results show differences at the overall level between the two classification systems, and also in the influence of the covariable. The influence of the classification system was significant for all the suitability indicators at a level of $p < 0.05$, except in the case of recall of the order, where it was $p < 0.1$ (Table 6). The estimated marginal means for each system show that the suggested classification system appears to be better to the current one, as it obtained better scores in 5 of the 6 indicators used (Table 7).

It can be seen that with the suggested classification system (B) it is easier to remember the order or hierarchy and there is a greater capacity for recognising categories, both generally and in order of quality. Also, considerably more information is learnt

[3] The significance level for the interaction statistics (Pillai, Wilks, Hoteling and Roi) was 0.11.Consequently, it was assumed that the slopes for each treatment are similar, so interaction was eliminated and the model was recalculated. In short, previous knowledge has not influence on the difference in means between the levels of the factor (current and new FCS). Therefore, in spite of previous knowledge existence, current classification could be compared with new classification.

Table 8
Mancova. Global differences between two Iberian ham FCSs (current system versus proposed system).

Effect		Value	F	Hypothesis df	Error df	Sig.
Classification type (C, D)	Pillai's trace	0.249	12.639	6.000	229.000	0.000
	Wilk's lambda	0.751	12.639	6.000	229.000	0.000
	Hotelling's trace	0.331	12.639	6.000	229.000	0.000
	Roy's largest root	0.331	12.639	6.000	229.000	0.000
Co-variable (prior knowledge)	Pillai's trace	0.012	0.475	6.000	229.000	0.827
	Wilk's lambda	0.988	0.475	6.000	229.000	0.827
	Hotelling's trace	0.012	0.475	6.000	229.000	0.827
	Roy's largest root	0.012	0.475	6.000	229.000	0.827

C = current system.
D = proposed system.

Table 9
Ancova. Differences between two Iberian ham FCSs (current system versus proposed system) in each of the six indicators.

Source	Dependent variable	Type III sum of squares	df	Mean square	F	Sig.
Classification type (A, B)	Recall (Y_1)	0.077	1	0.077	0.333	0.564
	Recall of order (Y_2)	2.878	1	2.878	1.755	0.187
	Recognition (Y_3)	8.638	1	8.638	7.652	0.006
	Recognition of order (Y_4)	16.330	1	16.330	17.491	0.000
	Information – right answers (Y_5)	1.624	1	1.624	0.287	0.592
	Information – wrong answers (Y_6)	0.726	1	0.726	0.406	0.525
Co-variable (prior knowledge)	Recall (Y_1)	0.028	1	0.028	0.122	0.727
	Recall of order (Y_2)	0.353	1	0.353	0.215	0.643
	Recognition (Y_3)	1.489	1	1.489	1.319	0.252
	Recognition of order (Y_4)	2.203	1	2.203	2.359	0.126
	Information – right answers (Y_5)	5.813	1	5.813	1.028	0.312
	Information – wrong answers (Y_6)	0.419	1	0.419	0.234	0.629

C = current system.
D = proposed system.

Table 10
Marginal means estimated for significant variables.

Dependent variable	C-D	Mean	Std. error	95% confidence interval	
				Lower limit	Upper limit
Recognition (Y3)	C	1.548	0.098	1.354	1.741
	D	1.166	0.097	0.975	1.357
Recognition of order (Y4)	C	1.257	0.089	1.081	1.433
	D	1.782	0.088	1.609	1.956

C = current system.
D = proposed system.

about each category (right answers) and it induces less confusion (wrong answers). In short, it seems that for orange juices, using a different number of images (three, two and one oranges) is better to recognise the categories and the information associated to each of them than the current system.

However, it is significant that in terms of recall, the current system obtained better results than the proposed system. This result could be explained by the *presence on the market* factor. In other words, while the consumers were only exposed to the proposed system for one minute, the current classification system has been used in the market for some time, so many consumers are familiar with the terms even though there was a certain amount of confusion about what they meant or which was better. In fact, the *presence on the market* effect could be considered a weighty argument to explain the differences between the two systems. With only one minute's exposure, it obtained better scores than the current system, which has been appearing on the orange juice labels seen in the shops for a long time now. In addition, given that all the categories have the same name (only changing the number of images) in the proposed system, it is difficult for categories to provide a semantic association which enhance the recall (Clark and Burchett, 1994; Dorfman, 1994).

6.2. Iberian ham model

Firstly, the homogeneity of slopes (or parallelism) hypothesis was examined by introducing the interaction between treatment and covariable into the model. Once the hypothesis had been accepted, the model was recalculated, eliminating this interaction[4] (Table 8). The results show differences at the overall level between the two classification systems, although the covariable has no effect.

Moreover, it is observed in the specific analyses (Table 9) that the type of system used has a significant impact on just two dependent variables: the recognition of categories and, to a greater extent, the quality order. The estimation of the effects according to the model reveals that the categories of Iberian ham are easily recognised when the current system is used (Table 10). However, in order to recognise the quality order of the same categories,

[4] The significance level for the interaction statistics (Pillai, Wilks, Hoteling and Roi) was 0.409.Consequently, it was assumed that the slopes for each treatment are similar, so interaction was eliminated and the model was recalculated. In short, previous knowledge has not influence on the difference in means between the levels of the factor (current and new FCS). Therefore, in spite of previous knowledge existence, current classification could be compared with new classification.

the results are better when the proposed classification system is used. Therefore, although the participants can recognise the current categories, they are not effective to distinguish the categories of ham based on the quality. We can conclude that the system with images is more useful for this purpose (which is one of the concerns of the industry) than the system of colours, which has been recently implemented in this industry.

Therefore, in both products the images help the consumer to better recognise the differences in quality of the two categories. This makes the decision-making process easier, and the price paid for each product is appropriate (moreover, this is an improvement for producers of quality foodstuffs). Thus, this could help to avoid confusion for consumers, as well as fraud.

7. Conclusions

This article proposes a general model for analysing the suitability or validity of any food classification system (and for comparing such systems) from the consumer's perspective. Starting from the hypothesis that the main function of any classification system implemented in the market is to be useful to consumers, firstly by reducing their confusion about types or classes of food, secondly by making it easier for them to learn the different categories and the characteristics of each category, and thirdly by making the food choice and selection process easier, the authors developed a model to analyse the suitability of any system. This suitability is directly related to the ability of any system to influence the process of learning and retrieving information (recall and recognition) on the part of the consumer.

Given the problems that have been observed with many of the systems currently used in the market, the proposed model presents a new approach that helps to meet a need, as it possesses a series of very useful characteristics.

The practical application of the model has demonstrated its technical viability. Once some FCSs have been chosen, the model can be applied easily in a short space of time at little cost. The features that make it technically viable include the model's sensitivity, in the sense that it is able to detect the usefulness of different alternative models, and that it makes it possible to examine different components of intrinsic quality, which in turn enables identification of the strong and weak points of each FCS in comparison with the other systems analysed.

Another important advantage that makes the model useful is its generality, as it can be applied (or adapted to) in many different contexts (different products and countries), since the learning and retrieval processes are universal among humans and do not depend on contextual factors (culture, social class, etc.). The model sets out the stages of application, the procedure and the indicators to measure, all of which are easily adapted to any product, market or culture.

A further important benefit is related to the process of drawing up an FCS, in that it could make this easier, faster and more transparent and, above all, could guarantee that it is genuinely being designed and carried out with its usefulness to consumers in mind. This advantage is easy to understand in view of the way that the current standards for many FCSs are developed. In general, they are drawn up by committees made up of a few specialists in standards, civil servants and sector representatives, who may have interests of their own and rein in any initiative that could affect these. In short, although the basic purpose of FCSs is to help consumers, this is not the objective of some of the agents involved in developing these systems and, as a result, systems are devised in which all the terms have positive connotations, resemble each other and clarify nothing. Applying the proposed model (or a similar one) could make the entire process more objective, removing the arbitrariness that could favour particular groups rather than the consumer.

Another interesting characteristic of the model is its potential usefulness for establishing general suggestions to guide future classification systems. Since it is a method of analysis, it not only makes it possible to identify what elements within a FCS are the most suitable, but also to suggest hypotheses about how an optimal FCS ought to be. Many questions can arise during the design stage of an FCS, such as: Is it better to use long terms (several words) or short ones? Similar words or totally different ones? Is it better to use illustrations (as in the oranges used in the present case)? Or numbers? Or letters? Or different colours? What is the optimum number of categories? All these questions can be posed in the form of hypotheses that can be studied using the model. Comparing different alternatives can generate conclusions which can provide useful guidance in designing future classification systems, so that from the start the approach bears in mind the characteristics that favour consumer learning, reduces the confusion and facilitates consumers' comparison and purchase processes.

Additionally, the model could also be applied for enhancing the information provided to consumers within a nutritional context. Although interesting suggestions have been made referring to the problem of informing facilitating learning by the consumers in the diet-health relationship (Aschemann-Witzel et al., 2013; Drescher et al., 2014; Olstad et al., 2015), it would be of great interest to compare the different alternatives proposed, along with other new ones in which different symbols are related with nutrition issues or recommendations. The phases of the model proposed can easily be adapted to evaluated sets of visual signs in order, in turn, to establish those that are better remembered, recognised and interpreted by the consumers. All this is intended to generate a set of universal signs to be introduced on labels or second labels that are sufficiently intuitive to be taught in schools.

In sight of these advantages, it is important to stress the implications of this work for policy makers. First of all, it would be appropriate to introduce a legal obligation to apply this kind of models before changing any FCS regulations, given the serious effects of a poor FCS on consumer and market behaviour. In short, taking in mind consumers and testing a new FCS should be obligatory steps in food policy. Besides, this recommendation could be an operative way to implement and guarantee consumers rights in food information, a key aspect of the European Union policy, as it is stated by Regulation (UE) No 1169/2011 on the provision of food information to consumers.

Finally, it is important to take into consideration two limitations. First one, the proposed model is a starting point for further research, and must be completed and improved. Thus, it is possible to incorporate new dimensions to the ones proposed, specially if it is intended to take the model as a reference for the study of consumers' food information processing. Second one, results show the convenience of modifying the current systems based on some deficiencies found between them and those used in this research. However, before proceeding to replace them, it would be advisable to carry out the study with more alternative proposals.

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Appendix A. Measurements of prior knowledge relating to ham and orange juices

Please indicate whether each of the following statements is true or false or you do not know.[5]

	True	False	I don't know
Acorn-fed ham is always black-footed ham			
Iberian ham only comes from acorn-fed pigs			
Serrano ham comes from Iberian pigs			
Iberian pastured, fodder-fed ham comes from fodder-fed pigs			
Iberian acorn-fed ham can come from cross-bred pigs (pure-bred Iberian pigs and pigs of other breed)			
There is almost no difference of quality among the types of Iberian ham			
White labelled or sealed hams are of higher quality than red labelled or sealed hams			
There are four types of seal: black, white, red and green			
Red-sealed hams are from acorn-fed pigs			
Green-sealed hams are from fodder-fed pigs			
The colour of the seal depends on the pigs' breed and diet			

	True	False	I don't know
All packaged orange juices have added sugars			
Orange nectar is made from concentrated orange juice			
Orange nectar is higher in fresh orange than orange juice			
Orange juice from concentrate is obtained by adding drinking water to the orange concentrate			
Orange nectar is the highest quality product			
Orange nectar is the healthiest product			
Orange nectar is the sugariest product			
Orange juice is 100% fresh squeezed orange juice			
Orange nectar has at least 50% orange juice or puree			
"Refrigerated" juice is a synonym of squeezed orange juice			
Packaged orange juices are higher in C vitamin than orange juices from concentrate			

[5] The items to measure the previous knowledge were developed considering the appropriate standard of each product and four depth interviews with experts.

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