



MULTIDISCIPLINARY STRATEGIES FOR UNDERSTANDING ILL-DEFINED CONCEPTS

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Abstract

Aims: The objective of the present work is to review strategies applied to decrypt multidimensional and ill-defined concepts employed by winemakers and to illustrate these strategies with recent applications.

Methods and Results: The first group of strategies are based in accessing long-term memory of experts including description and association tasks. For example, in a recent study, Spanish experts were asked to provide a sensory description of a green wine from memory. Terms such as “vegetal aroma” and “unpleasant/default” were shared by experts from different regions in Spain, while “excessive sourness”, “astringency” and a term linked to wine phenolic compounds such as “tannin” presented an important idiosyncrasy related to the region of origin of winemakers. Previously, a word association task was applied for understanding the concept of minerality. Place-related (Chablis, geology and terroir) and sensory dimensions (shellfish, chalky and freshness) appeared to be the core of the concept for Chablis winemakers. The second group of strategies involves sensory tasting and chemical characterization. It was used for deciphering perceived quality, minerality and green wine concepts. This strategy includes two main steps, description of samples and chemical analysis of volatile and non-volatile chemicals with sensory activity by either targeted or untargeted instrumental approaches. For example, for a set of Spanish red wines and following a targeted instrumental approach, the samples evaluated by Spanish experts as highest quality were associated to high levels of norisoprenoids, and low levels of whiskylactones and higher alcohols.

Significance and Impact of the Study: The multidisciplinary approaches involving sensory (including both mental and tasting approaches) and chemical strategies are pertinent and effective for deciphering multidimensional and ill-defined concepts. These approaches are useful for improving the understanding and communication among people of the wine sector. These approaches can also help the industry to optimize grape and wine production stages to achieve the desired sensory characteristics by feeding into practices for modulating the composition of wine at different production stages. Finally, these approaches are an important source of knowledge for everyone interested in science of wine tasting.

Keywords: Sensory, description, memory-based strategies, tasting, sensory-active

Introduction

In the context of sensory characterization of food products, and of wine in particular, sensory profile is a valuable piece of information. First, in terms of product development, because it can help in the production processes by defining the desired composition of the wine and thus fulfil producer's requirements. But also, in terms of consumer's acceptance, as it provides information that will allow to achieve a specific and desired sensory profile fulfilling consumer expectations, then assuring the success of the wine in the market. Conventional descriptive analysis (DA) is among the most widely used techniques for sensory profiling, as it provides an accurate description of the wines. However, it is a technique that is very time and money consuming, mainly because it needs a panel training step involving the generation of terms and development of reference standards for reaching consensus among panelists (Lawless and Heymann, 2010). Alternatively, in recent years, descriptive analyses carried out by consumers have gained importance, becoming an interesting alternative to DA (Valentin *et al.*, 2012; Varela and Ares, 2012). These descriptive techniques are attractive firstly because the training stage is not necessary, and secondly because they allow to establish a direct relationship between the data derived from the level of acceptance of the product (hedonic data) and the properties of the product perceived by the consumers themselves. The latter advantage refers to the fact that classically, the evaluation of product acceptance is carried out by consumers, while descriptive analysis is performed with trained panels. These two sets of data are related to identify the characteristics of the product involved in the acceptability of the product. In this case, it is assumed that the perception of the product by the trained panel and the consumer is similar, which can sometimes lead to incomplete or confusing conclusions. While descriptive techniques carried out by consumers can be good alternatives to classical DA, they present an important drawback, which is related to the difficulty in interpreting the terms generated because consumers use "everyday language" to describe products (Lawless and Heymann, 2010). This is why a third alternative for generating sensory profiles refers to descriptions produced by technical experts, which is a resource widely spread in the wine domain. Expert descriptions are more consensual and thought to be easier to interpret than those of consumers. To this regard, technical experts seem to generate intermediate descriptive profiles between trained panels and consumers, as they have developed a specific descriptive language that includes both "scientific terms" that can be unequivocally interpreted, but also "everyday language", which refers to individual previous experience as reported by Lawless and Heymann (2010) (see Figure 1 for an illustration of the intermediate role of technical experts in wine description). This last type of language refers to descriptive terms that are difficult to interpret, being some good examples of ill-defined sensory concepts "minerality" (Parr *et al.*, 2011; Rodrigues *et al.*, 2015), "complexity" (Parr *et al.*, 2011), "bouquet" (Picard *et al.*, 2015) or "green" (Sáenz-Navajas *et al.*, 2018) among others.

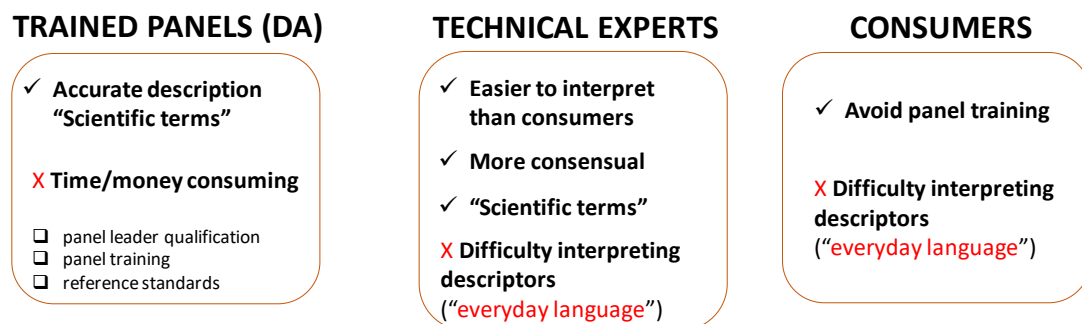


Figure 1: Illustration of the main advantages and disadvantages associated to the sensory description carried out by trained panels (descriptive analysis, DA), technical experts and consumers.

The objective of the present proceedings paper is to present the strategies that have been proposed in the literature to decrypt ill-defined concepts employed by technical experts. These strategies can be classified in two main groups. The first group, which we will refer to as memory-based strategies, includes associative or descriptive tasks, carried out from memory with no tasting. The second group, which we will refer to as tasting-based strategies, includes strategies based on the combination of sensory tasting and chemical quantification of sensory active compounds.

Memory-Based Strategies

Free Descriptions from Memory

Regarding the first group of strategies, sensory description performed from memory have been used successfully to distinguish the sensory profiles of 12 Portuguese Protected Geographical Indications (Jose-Coutinho *et al.*, 2015). More recently, a similar strategy, based on long-term memory of winemakers, was applied to understand the concept of green wine (Sáenz-Navajas *et al.*, Under review). A total of 77 Spanish winemakers from four Spanish regions, producing mainly red wines, carried out a free description task from memory via an on-line questionnaire. They were asked to remember the last green wine they tasted, and to describe it with as many words as they wanted. Words elicited were firstly lemmatized and synonymous were regrouped. Then, the terms were arranged in categories and subcategories. Results firstly showed that the “green” concept elicits two main categories of words related to 1) sensory attributes, and 2) the origin of the green character in wines. This last being related to a higher-order cognitive process in which experts are able to make a diagnosis based on their technical expertise. Secondly, the multidimensionality of the “green” wine concept was evidenced in that it was related to aroma, taste, trigeminal, color, and hedonic sensory subcategories. Thirdly, “vegetal aroma”, “bitter” and “unpleasant” were revealed to be specific terms shared by experts from the four regions to describe “green” wines, suggesting that they may represent the core of the green wine concept. Interestingly, despite these commonalities, an important regional effect was observed. While for experts from DO Campo de Borja and DO Ribera del Duero the “green” concept was mainly related with terms belonging to the aroma modality (“vegetal” or “herbaceous” aroma), winemakers from DOPa Rioja and DO Somontano associated green wines also with taste and mouthfeel properties such as “excessive sourness” and “astringent” sensations as well as with wine components (“tannin”). This effect was attributed to technical and sensory experiences differing among experts from distinct wine regions and thus contributing to the formation of diverse wine concepts.

Free-Association Task

Among the memory-based strategies, association tasks are among the most commonly employed to decipher sensory concepts, more specifically, the free word association task (Parr *et al.*, 2011; Abric, 2003). In a free word association task, participants are asked to indicate the first words that come to their mind when prompted with a target word. This strategy can be illustrated by the work of Rodrigues *et al.* (2015), which aimed to understand the sensory concept “minerality” using the social representation as theoretical framework. This intangible descriptor appeared to be a positive quality driver of the wines from the French Chablis region based on testimonies of winemakers from the region. Consumers from Dijon and wine experts from Chablis in Burgundy (France) participated in the study. Face-to-face interviews were conducted. Participants were prompted with the instruction: “When I say the word “minerality”, what comes to your mind?”. They had to write all the words which came spontaneously to their mind. In a second step, they were asked to assess the importance of the words they generated on a ten-point scale (1 = not important; 10 = very important). Results indicated that experts and consumers had somewhat different concepts of minerality. Place-related dimensions were common to the core concept of minerality for both experts (Chablis, geology and terroir) and consumers (terroir), while sensory dimensions (shellfish, chalky and freshness) were part of the core of the concept only for winemakers.

Tasting-Based Strategies

Rate-All-That-Apply (RATA) and Untargeted Instrumental Approaches

The second group of strategies involves sensory tasting. Their main advantage is that this type of strategies allows to include a second step after the tasting step, to identify sensory-active molecules driving the sensory perception. The work carried out to decipher the concept of green wine, in the Spanish Somontano region (Sáenz-Navajas *et al.*, 2018) is a good illustration of this type of strategy. In a first phase, 38 red wines with *a priori* different levels of green character were preselected by winemakers from the region studied. These wines were sensory evaluated by a group of established winemakers from Somontano region. The sensory task involved two steps. Firstly, they were asked to evaluate the green character and preference of the 38 wines, and in a second step, they described the wines making use of a score card widely used in the region, that includes aroma (intensity, oxidation, vegetal, fresh fruit, ripe fruit and wood) and in-mouth (sweet, sour, astringent, greasy, green tannins, dry tannins) terms rated on five-point scales. Results showed that green character (as used by winemakers from Somontano region) was positively correlated ($P < 0.05$) with terms employed by technical experts to describe aroma (“vegetal”) and in-mouth terms (“dry tannins”, “astringency”, “green tannins”), and negatively to woody aroma, sweet taste and “greasy tannins”. The negative valence associated to green character was confirmed by the negative correlation ($P < 0.05$) observed between green and preference scores.

This sensory task further allowed to have a ranking of wines in terms of green score. The two wines with higher and the two wines with lower green score were selected and chemically studied to identify both nonvolatile and volatile molecules with sensory activity involved in the green sensory concept. The nonvolatile extract was fractionated by preparative chromatography followed by solid phase extraction (SPE) as described previously (Sáenz-Navajas *et al.*, 2017), to obtain a total of six fractions per wine. For volatiles, Gas chromatography with olfactometer as detector (GC-O) was carried out to identify aroma zones involved in green character. The sensory activity of the nonvolatile fractions was evaluated offline (i.e., once fractions are isolated), following a RATA methodology developed for taste and mouthfeel characterization of fractions and wines (Sáenz-Navajas *et al.*, 2017). Meanwhile, GC-O is an online system, that allows the separation and sensory characterization of odor zones simultaneously. The sensory-directed strategy used in this project following untargeted instrumental approaches led to the identification of three groups of compounds as possible candidates involved in the enhancement of the green character of wines: isoamyl alcohol, anthocyanic and tannic fractions. The final step consisted in the addition of these candidates to non-green wines with the objective of confirming their sensory activity and involvement in the development of green character. Results showed that the presence of only one of the components did not generate any sensory change, while the presence of isoamyl alcohol together with either the anthocyanic or tannic fractions induced an increase in the green character of the non-green wines. This increase in the green score of wines was mainly related to increases in astringency perception, which was more important when the three components were added. This study allowed to identify compounds with sensory activity able to modulate the green character of the studied wines.

Check-All-That-Apply (CATA) and Targeted Instrumental Approaches

As a second illustration, the tasting-based strategy was also successfully applied to decoding intrinsic quality perception of red wines (Sáenz-Navajas *et al.*, 2015). This task was carried out with 12 red wines that were evaluated in terms of intrinsic quality following a categorization task by a total of 119 experts and 108 consumers from two regions with marked tradition in wine production (DOCa Rioja, Spain and AOC Côtes du Rhône, France). These wines were sensory characterized by two trained panels following the CATA methodology. In a second step, unlike the sensory-directed methodology attending to untargeted instrumental approaches illustrated in the previous example of green wine, compounds with known sensory activity were quantified (volatiles by GC-FID and GC-MS; nonvolatiles by HPLC-MS), (i.e., following targeted instrumental approaches).

Concerning the results derived from quality evaluation, it was firstly observed that wine experts from both studied regions, in Spain and France, shared similar criteria related to intrinsic quality. Their quality scores were significantly ($P < 0.01$) correlated as were those of consumers ($P < 0.05$) from both regions. Differently, no relationship between consumers and experts' scores within regions was observed. This result highlighted that perceived intrinsic quality depends on the level of expertise of the consumer. Further correlation studies between quality scores with both sensory descriptions and chemical composition, showed that experts attached higher quality to wines higher in red fruity aromas, related to higher levels of norisoprenoids, and lower in polyphenols and whysylactones. Differently, consumers linked quality to wood-related aromas, and surprisingly, to the leather-like compound 4-ethylphenol. This result is interesting since the role played by this compound is controversial on consumers' perception. This seems to be unclear and dependent on both consumers' expectations and familiarity with this aroma and matrix composition. Concerning the first, it can be hypothesized that consumers from both regions can have been exposed to oaked wines that have also some leather character, which can have led them to associate oaked wines with this leather-like aroma, and thus with quality. Concerning the matrix effect, a possible masking/suppressor effect generated by both polyphenols and woody-related aromas on the leather character elicited by 4-ethylphenol could occur. This effect could have led to a subtle or lack of leather aroma in wines with higher levels of ethylphenols.

Conclusions

Wine descriptions carried out by wine experts include terms that can be unequivocally represented by sensory references, but also terms derived from their personal experiences, which are difficult to unequivocally interpret. Multidisciplinary approaches including both memory-based and tasting-based approaches are shown to be complementary and effective for deciphering ill-defined concepts linked to "everyday language" employed by technical experts. The advantage of memory-based approaches, is that they do not require the infrastructure needed in tasting-based approaches, and consume far less time and resources. While tasting-based techniques involve the study of a limited number of samples, which can lead to a lack of representativeness of the studied sensory concept. In contrast, they can be followed by chemical characterization (targeted or untargeted instrumental analysis) for the identification of sensory-active compounds modulating the studied sensory

concept. See Figure 2 for a summary of advantages and disadvantages associated to memory-based and tasting-based tasks.

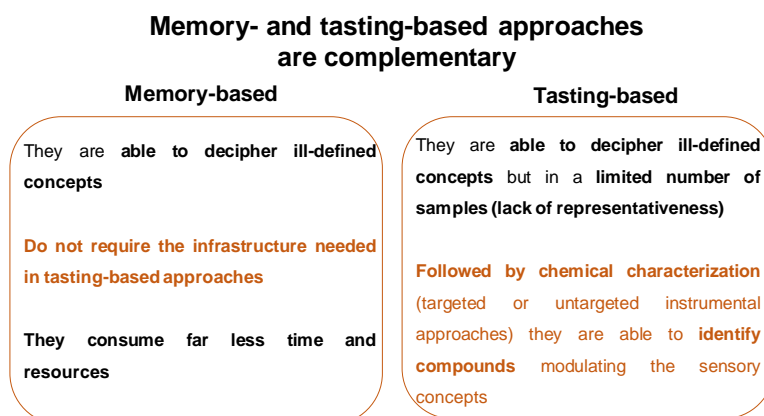


Figure 2: Summary of advantages and disadvantages of memory-based and tasting-based strategies employed for deciphering ill-defined sensory concepts.

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