A New Wine Tasting Approach Based on Emotional Responses to Rapidly Recognize Classic European Wine Styles

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Abstract: Conventional tasting sheets are widely used to evaluate wine quality in wine tasting competitions. However, the higher scores are mostly obtained by international commercial wines, resulting in lower scores being awarded to the classic European wines. We hypothesize that this is due to the tasting methodology that fails to recognize this wine style. Therefore, the purpose of this work was to show the implementation of a new wine tasting approach to overcome this drawback. The proposed training technique is based on the emotional responses of the taster after smelling two wines of clearly opposite styles. The first wine is characterized by high aromatic intensity but low in-mouth intensity, perceived as disappointing to the taster, here defined as an "easy" wine. The second wine is characterized as a wine with low aromatic intensity but that provides an unexpectedly positive in-mouth experience, here defined as a "difficult" wine. These emotions are explained by the wine sensorial characteristics. The "easy" wine has an intense, simple smell with short persistence while the "difficult" wine has a low intensity, complex aroma, and long persistence. The first style corresponds to the international commercial wines most prized in international wine challenges. The second, frequently rejected by untrained tasters, is consistent with the "so called" classic European wines, and is characterized by light red or yellow straw colors, weak smell intensity, and aggressive mouth-feel. After no more than four training sessions and using the OIV tasting sheet, inexperienced tasters were able to score "difficult" wines equally as "easy" wines and understand their different attributes. In conclusion, this new tasting approach may be used by wine professionals to explain the characteristics of high quality wines that are not easily recognized by untrained consumers.

Keywords: wine tasting; emotional responses; consumer research; wine challenges; wine styles; OIV tasting sheet

1. Introduction

Wine sensory description is not an easy or consensual task even when employing widely-accepted tasting methods. Different tasting sensitivities [1] due to verbalization abilities [2], cultural background [3], and level of expertise [4,5], all explain why the same wine may be judged very differently even by experts. Conventional descriptive analysis (DA) is the most widely used method used to establish both quantitative and qualitative differences among wine samples and obtain their sensory profiles [6]. Recently, other approaches, such as free choice profiling, free sorting task, or projective mapping, have been used [7]. Sensory profiling is often used in conjunction with hedonic ratings to understand the main sensory drivers of consumers' preference, acceptability, or quality perception [8,9].

Interest in new sensory-based methodologies, which can be performed by panels with different degrees of training or with consumers, has increased over the last decade [10]. One of these new approaches is to understand food choice and consumer behavior using food-evoked emotions. Several methods have been developed to measure the predominantly positive emotions associated with foods [11–17]. To the best of our knowledge, emotional responses have only been applied to wine by Ferrarini *et al.* [18] who defined a list of 16 emotions that allowed wine consumers to describe their feelings, although in that study, wines were only described and no wines were actually tasted. Consequently, no attempt was made to relate emotions to the intrinsic characteristics of the wines.

The training of wine tasting is presently a fashionable leisure activity for consumers. In parallel, sensory research studies use DA developed by experts to typify wine characteristics. Both consumers and experts have the same ability to detect wine aroma and taste [19]. The different preferences among experts and consumers are explained as a matter of personal taste influenced by culture and level of expertise [4,6,20]. Considering these different preferences, it would be expected that when large tasting panels are used in wine challenges, the winning wines would have different styles given the number of judges preferring one or other style. However, we hope to demonstrate through this study that the methodology used in these challenges, based on the International Organisation of Vine and Wine (OIV) tasting sheet, frequently values and awards the so-called international style which is characterized by intense aroma and sweet and full mouth-feel. The increased value of these "international" wines gives little opportunity to the discretely-flavored, rough and acidic "European style" wines. As wine professionals, our main challenge associated with wine tasting has been how to explain, and clarify the quality of these wines, which contrasts with the present globalized market tendencies. This goal is hard to achieve when the successful commercial wines are those most prized in international challenges. Therefore, the purpose of our work was to develop a new tasting methodology that could provide an efficient recognition of the classic European wines. This approach is based on differential emotional expectations. Ultimately, this work could serve to bridge the gap and facilitate communication between consumers and wine professionals.

2. Results

2.1. Evolution of the Characteristics of "Great Gold" Awarded Wines

The style of wines most prized in international challenges can be inferred from their chemical and sensorial analysis. Challenge organizations either do not have or are not required to publish these data, with the exception of the Mundus Vini wine challenge. This challenge uses the OIV's tasting sheet and recommendations. We used the ethanol content and sugar concentration, publicly available at www.mundusvini.com (see material and Methods), of red wines scored as "Great Gold" and constructed the graph shown in Figure 1. The number of awarded red wines varied from two in 2007 to 15 in 2011. The numbers of white wines receiving this award was too small to generate a relationship with chemical and sensory data. The most significant result was the tendency to prize wines with higher sugar level and high ethanol content. In particular, the high sugar of 2011 and 2012 was due to the scores of Italian Amarone wines characterized by high ethanol and residual sugar concentrations. However, even if the years 2011 and 2012 were removed from the plot, the tendency of the increase in sugar levels would be maintained (results not shown). The average total acidity, around to 5.6 g/L, did not change significantly during these years (results not shown). Therefore, the use of OIV tasting methodology as applied by wine challenges appears to favor the recognition of high ethanol wines with sweet taste.

The ethanol content varied from 14.1% (v/v) to 15.0% (v/v) with a slight tendency to increase in the "Great Gold" awarded wines from 2004 to 2014. This observation is in accordance with the steady increase of ethanol content worldwide reported by King *et al.* [21]. These authors advised the separation of wines between low alcohol (<14% v/v) and high alcohol wines (>14% v/v) in wine competitions because of ethanol influence on wine judgments. Therefore, the variation of ethanol levels observed

in the Mundus Vini competition (over 14% *v/v*) should have not influenced judges preferences and probably reflects the influence of climate change [22,23]. On the contrary, the steady increase in residual sugar concentrations influences wine acceptance favorably [24]. Knowing that sweetness was shown to be preferred by novices [24], it seems that OIV methodology tends to represent their preferences. Accordingly, these most prized wines were characterized by deep red color, intense smell with oak related notes, sweet taste, and non-aggressive mouth-feel, as retrieved from tasting notes generated during the competition. The perception of quality linked to oak flavor and lack of astringency was recently demonstrated with consumers from Rioja (Spain) and Côtes du Rhône (France) and these results conflicted with results of experts from the same regions [6,20]. As a consequence, when consumers and experts taste together in wine challenges, a higher score will most likely be assigned to wines with intense fruity-oaky smells and full, smooth mouth-feel, leaving fewer chances for the recognition of classic European wines. These preferences were also reported with Californian wines judged by individuals of different degrees of expertise [25]. Although we could not confirm these results in other internationally-recognized challenges, our experience as wine judges and empirical knowledge of other awarded wines leads to the same conclusions.
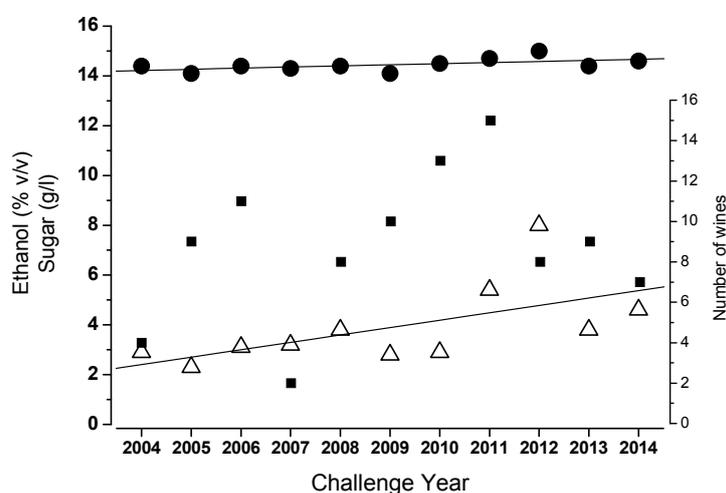

Figure 1. Evolution of ethanol (●) and sugar (Δ) concentrations of red wines awarded as "Great Gold" (■ number of wines) in the Mundus Vini wine challenge. Values were obtained from www.mundusvini.com (accessed between May and July 2014).

2.2. Training of the Emotion Based Tasting Approach

We tested the emotion based approach, as described later in Material and Methods, using two tasting panels recruited from university students, one from the Viticulture and Enology Master and another from the Gastronomical Sciences Master. Two wines with opposite characteristics (anchor wines) were used in the first training session: one defined as "easy" because it was appreciated by most tasters without any previous training; and another defined as "difficult" because its quality was not evident. The "easy" wines were a young white Muscat varietal and a full-bodied, oaked, red blend and the "difficult" ones were a Chardonnay 1st Cru Chablis and a Pinot Noir 1st Cru Saint Aubin (Burgundy). The most frequent responses and comments given to the tasted wines using the new tasting approach are shown in Table 1. Despite the different background of the tasters, the responses were supportive of our previous results from many informal consumer tastings. The so-called international style wines characterized by high aroma intensity and low complexity had higher rates of approval by most tasters. On the contrary, the Chablis and Pinot Noir styles were frequently noted as flavor-defective with a harsh mouth-feel. However, when questions were asked about the emotional expectations after smelling, the responses revealed that those highly aromatic wines were disappointing in the mouth. On the contrary, reactions of high surprise were obtained

when the "difficult", less aromatic wines, were tasted. In addition, the evolution of the aroma with time revealed other pleasant flavors; this increased the acceptance of this type of wines while those wines with a high initial aromatic impact became more simple and cloying over time.

Table 1. Typical comments given by the tasting participants to the anchor wines representing the two opposite styles used in the first training session of the emotional tasting.

Features	"Easy" Wines		"Difficult" Wines	
	White	**Red**	**White**	**Red**
Visual	Nice light yellow color	Deep red color, a great wine is expected	Dark yellow, it should be oxidized, no expectations	Light red, a light red wine, no expectations
Limpidity	Limpid	Limpid	Limpid	Limpid
Smell intensity	Intense, fantastic, appealing, high expectations	Intense, fantastic, appealing, high expectations	Discrete, smells badly, it stinks!	Discrete, smells badly, it stinks!
Dominant smell	"Sweetish" smells (flowery and fruity) Happiness to recognize the smell!	"Sweetish" smells (black and overripe fruit) Happiness to recognize the smell!	Difficult to define, "harsh" (vegetal, earthy) Is changing! Unhappy for being unable to recognize the smells	Difficult to define, "harsh" (vegetal, bush) Is changing! Unhappy for being unable to recognize the smells
Evolution	Stable	Stable	Changes favorably	Changes favorably
Expectations for the taste	High	High	Low	Low
Feelings after tasting	Deception It disappears!	Deception It disappears!	Surprise It is tasty!	Surprise It is tasty!
Dominant perception	Sweet	Sweet	Acid, possibly salty	Acid, possibly salty
Mouth-feel	Smooth, hot Nice!	Smooth, hot Nice!	Irritating, chilly Aggressive, harsh	Irritating, chilly Aggressive, abrasive
Overall preference	High	High	Low	Low
Reassessment	Smells and tastes the same	Smells and tastes the same	Improved with time, It's another wine!	Improved with time, It's another wine!
Final conclusions	Simple, short and smooth Easy to understand	Simple, short and smooth Easy to understand	Complex, persistent and vibrant Requires learning and time	Complex, persistent and vibrant Requires learning and time

The requirement for additional tasting time for each wine is not possible in wine challenges where many wines are evaluated consecutively. Therefore, judges trained by the emotion-based approach described below may learn, in about one hour, how to anticipate the probable evolution of the different styles of wine. Individuals with less training may take some more time but achieve the same ability in a few sessions, as described below.

2.3. Evolution of Tasting Scores with Training

In the development of this method, tasters scored the selected wines using the OIV tasting sheet of the Mundus Vini challenge (results of all tasting sessions are presented in Supplementary Figures S1–S3). We performed an one-way Analysis of Variance (ANOVA) and only in the first tasting session, the "easy" red wines presented a higher score than the "difficult" red wines ($p < 0.05$), as would be expected, as they corresponded to the wines defined as "easy" and many have been awarded gold medals. In the subsequent tasting sessions, both tasting panels equally rated "easy" and "difficult" wines. The variation in taster's scores was relatively high as reflected by the high standard deviation of the mean score as usually observed in wine tastings [6]. However, despite this variability that makes mean scores not different, a tendency could be observed reflecting the increase of the lowest values given to "difficult" wines (Figures 2–4). We hypothesized that inexperienced tasters following this methodology gained in these understanding of the range of wine quality. Further, we believe that

this recognition is mainly due to the focus put on the dichotomy between expectations and sensory properties, and not only merely on the sensory properties of the wines. The purpose of the training method was not to change tasters' preferences but the outcome was that the appreciation of "difficult" wines changed, as did the definition of what constitutes a quality wine. As a consequence, in up to five sessions, the panelists were able to give "difficult" wines quality ratings equal to "easy" wines. The last session of 2014 was particularly illustrative of this change, where a classic European old red wine with red-brick color and acid mouth-feel (RD11) was given a mean score equal to that of a gold awarded full-bodied red wine dominated by oak flavors and sweet mouth-feel (RE11).

Findlay *et al.* [26] found that nine training sessions were necessary to prepare panels to make an aroma descriptive analysis of white wines. Although with a different scope, this method meets the requirement for faster sensory methodologies without the requirement for highly-trained assessors [10]. In addition, it shortens the distance between sensory and consumer sciences, which is a challenge that must be tackled by the food industry [27].
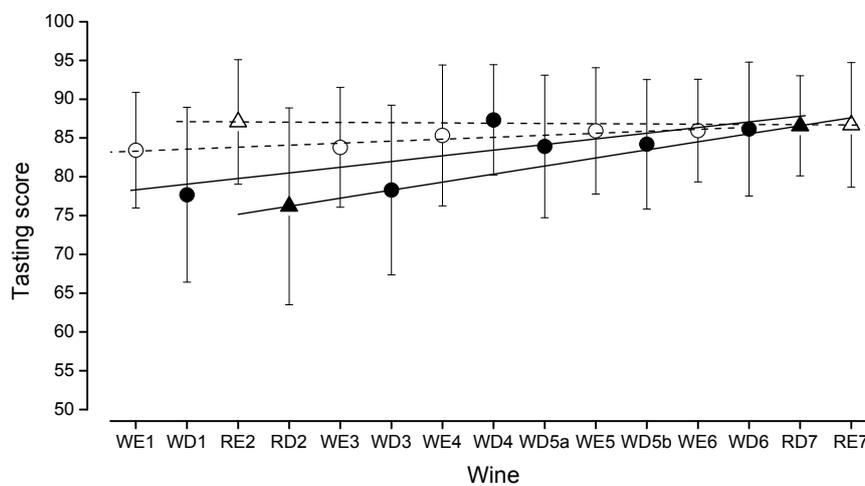

Figure 2. Evolution of tasting scores given by the 2012 panel to white and red wines ("easy" wines, open symbols; "difficult" wines, filled symbols; white wines, circles; red wines, triangles). Straight lines were obtained by linear regression of mean score values ("easy wines", dashed lines; "difficult" wines, solid lines). Bars indicate standard deviations of the mean scores. Wine references are described in Table 4.

Figure 3. Evolution of the tasting scores given by the 2014 panel to white wines ("easy" wines, open symbols; "difficult" wines, filled symbols). Straight lines were obtained by linear regression of mean score values ("easy wines", dashed lines; "difficult" wines, solid lines). Bars indicate standard deviations of the mean scores. Wine references are described in Table 4.
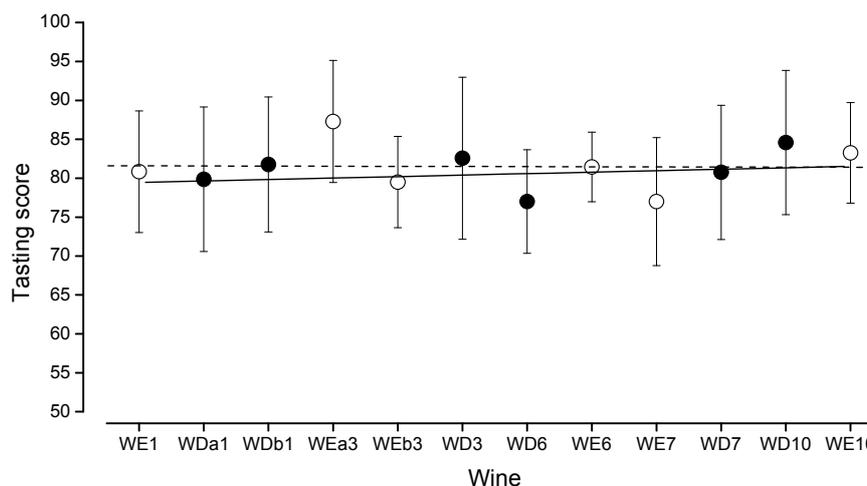
Figure 4. Evolution of the tasting scores given by the 2014 panel to red wines ("easy" wines, open symbols; "difficult" wines, filled symbols). Straight lines were obtained by linear regression of mean score values ("easy wines", dashed lines; "difficult" wines, solid lines). Bars indicate standard deviations of the mean scores. Wine references are described in Table 4.
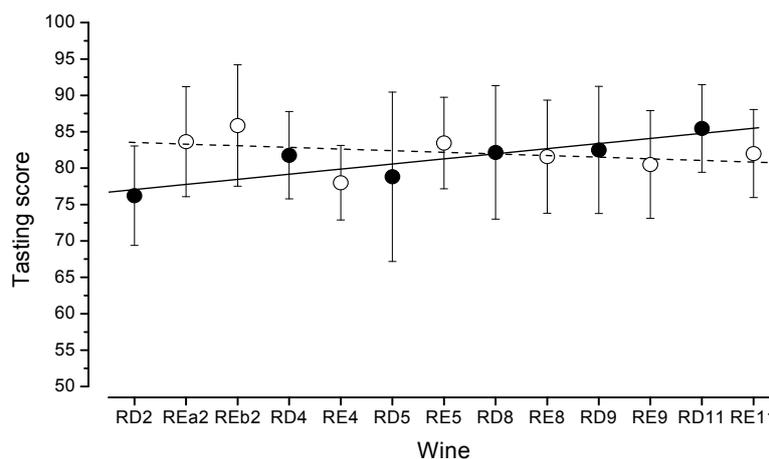
3. Discussion

We have shown in this work that a new tasting training approach may be performed to provide examples of different wine styles, thus expanding the tasters' definition of quality. This training resulted in increased liking for the classic European style of wines. This approach is unusual since it requires the description of emotions or expectations instead of only using the typical sensory attributes associated with wine tasting. This methodology was easily understood by tasters of diverse cultural and expertise background. In fact, the results here described concur with the notion that complexity and quality for consumers appears to be very much driven by expectations of a particular sensory experience that includes pleasure and enjoyment [4].

In the approach described in this study, the main focus was on the relationship between aroma and taste/mouth-feel which was illustrated using two very distinct wine styles as anchors. This clear distinction is obtained when typical examples of the so-called international and classic European wine styles are chosen [28]. The ability to discriminate the typicality of these wines is critical since today these styles are not confined by geography [29]. The first wine style is intensely flavored, giving rise to initial high expectations that often lead to frustration and disappointment once the wine is placed in the mouth. The second wine style has a low aromatic profile, perhaps with some initial unpleasant odors, but delivers a surprisingly positive in-mouth experience, with pleasant flavors and long finish. Given these two extreme anchors, it is possible to better define the wines with intermediate sensory properties. This type of approach, using sensorial comparisons and defined anchors, has already produced meaningful descriptions of waters [30] and sparkling wines [31]. Another important aspect is to re-taste the wines after several minutes, and see how the second style evolves and shows other flavors, while the first is constant and tends to disappoint or annoy the taster.

Our purpose was not to change individual preferences but results showed that less experienced tasters expanded their understanding of wine complexity and persistence. These are attributes most prized by wine connoisseurs and by using this approach consumers may rapidly understand them without the need of years of experience, acute sensitivity, or particular preferences as thought to be necessary to enjoy a Chardonnay or a Pinot Noir from Burgundy. The fame of these wines reflects their undisputed quality but the equivalent style of wines from unrecognized denominations tend to be commercially disregarded, with the result being that winemakers direct their efforts to make the globalized styles because "the market demands". Hopefully, the introduction of this approach in a short training sessions before the challenge tastings would help in increasing the recognition of the classic European wines.

In conclusion, this new tasting approach enabled the efficient recognition of high quality wines that are often underscored using the conventional tasting sheets. Additionally, responses to emotional expectations supported a more consensual and meaningful wine description so that wines may be better explained by wine professionals and appreciated by consumers.

4. Materials and Methods

4.1. Characterisation of Wines Most Prized by International Wine Challenges

In a web search, we found that the Mundus Vini Wine Challenge is the only competition that publishes the summary chemical analysis and a sensory profile of the wines, of the awarded wines in the site www.mundusvini.com (accessed between May and July 2014). For this study, we selected only the most prized red wines scored as "Great Gold" from 2004 to the spring tasting of 2014, with the idea that these wines would reflect the best quality judged by an international and diverse tasting panel. Ethanol content, total acidity, and sugar concentration of each wine were obtained from the published data in the website and plotted by us to determine possible trends in wine composition along the years. In addition, published sensory profiles were qualitatively evaluated.

4.2. Tasting Panels and Conditions

Two different tasting panels were composed by students of (i) the first year of the Master in Viticulture and Enology of 2012 and (ii) the first year of the Master in Gastronomical Sciences of 2014, both held at the Instituto Superior de Agronomia, University of Lisbon. A total of 32 students (16 women, 16 men, from 21 to 36 years old) participated in 2012 and 21 students (12 women, nine men, from 23 to 55 years old) participated in 2014. Sensory analyses were conducted following the spirit of the Helsinki Declaration. The purpose of the study was previously explained to all participants that gave their oral consent to participate and were not paid for this task. Wine tasting studies are not mentioned under the scope of the National Ethics Committee for Clinical Research (www.ceic.pt). The wine tasting knowledge was variable among the students but most had no previous experience on wine tasting.

Students were asked to evaluate wines using the conventional OIV tasting sheet for still wines as used in the Mundus Vini challenge (OIV-Concours 332A-2009, www.oiv.int) and, in parallel, using an emotion-based tasting sheet developed in this work and described below (Table 2). Tastings sessions, performed in the classroom, included two or three wines, served blind and poured (30 mL) in International Standards Organization (ISO) standardized clear tasting glasses, with a duration of 45 to 60 min each. Scores obtained with the OIV sheet were statistically treated (one-way ANOVA, $p < 0.05$; linear regression) and results plotted using the Origin 6.0 software (Microcal Software, Inc., Northampton, MA, USA).

Table 2. Emotion-based tasting sheet and attribute description.

	Attribute and Score Range	Short Description
	Initial Impression—Distaste (1) to Attraction (5)	Emotion: wine's appeal after the first smell
	Intensity—Weak (1) to Strong (5)	Evaluate intensity as the distance between the nose and the glass top when the smell begins to be sensed
Nose	Elegance—Cloying (1) to Subtle (5)	"Cloying/ostensive"—feeling after imagining smelling and drinking the wine every day for a fortnight "Subtle"—opposite of cloying and associated with wines that have a delicate smell
	Complexity—Easy (1) to Difficult to describe (5)	"Easy"—odors easily identified, tasters agree with one or two descriptors "Difficult"—absence of dominating main odor, several descriptors arise from different tasters
	Expectations for the mouth—Low (1) to High (5)	Emotion: expectations for the mouth assessment that were created by the smell

Table 2. *Cont.*

	Attribute and Score Range	Short Description
Mouth	Relation to smell—Disappointing (1) to Surprisingly good (5)	Emotion: response to the expectations raised by the olfactory assessment
	Thermal sensation—Cool (1) to Hot (2)	Tactile sensation of heat revealed by the wines when tasted at the same temperature
	Creaminess [a]—Dry (1) to Jammy (5)	Tactile sensation of texture
	Fullness [b]—Light (1) to Full-bodied (5)	Tactile sensation of wine body
	Harshness [b]—Smooth (1) to Abrasive (5)	Tactile sensation of roughness
	Persistence—Short (1) to Long-lasting (5)	Duration of the sensations in mouth and retronasal pathway
	Prevailing flavors—Sweet (S), Salty (S), Harsh/Bitter (H/B), Acid (Ac)	Identification of the dominating taste and flavors
Final nose	Evolution of the fragrance in the glass—Unchanged (1) to Fully developed (5)	Changes of the smell in the glass during time
	Duration of the fragrance in the glass—Short (1) to Very Prolonged (5)	Time of smell permanence in the glass
Overall	Disagreeable (1) to Exciting (5)	Emotion: overall response to the tasted wine
Visual	Color—White (W), Rosé (P), Red (R)	Just record the color
	Appearance—Clear (C), Cloudy (Cl), Murky (M)	Just record the appearance
	Condition—Young (Y), Developed (D), Tired (T)	Just record the condition

[a] Only for white wines; [b] Only for red wines.

4.3. Description of the Emotion Based Approach

The tasting sheet used in this work gathers conventional descriptors, as defined in several textbooks of scientific [32,33] or divulgation nature [34,35], and emotional responses suggested by our previous empirical experience with consumer tastings. Detailed description of the several worldwide wine examples given below may be found in several references [28,29,32–35]. Our aim was to explain those emotional responses as a function of wine sensory properties. Hopefully, factors affecting these properties (e.g., climate, winemaking technology) will be more easily understood by consumers, as described below.

The tasting protocol, presented for the first time in this work, does not start with a detailed visual examination as we consider that visual features bias the evaluation of smell and taste as demonstrated by [36]. Next, nose and mouth evaluations follow the conventional sequence of tasting protocols.

4.3.1. Nose Evaluation

Initial Impression

The olfactory examination begins with an emotional "initial impression" of the wine, based on the wine's appeal. This reaction is notable in novices as they show strong attraction, or positive emotions, if the smell is intense. Conversely, negative emotions are shown if the wine displays strange, exotic, or unpleasant aromas. These emotions immediately create expectations for the in-mouth evaluations of the wines. The wine experts generally understand which wine style corresponds to intense smells and, consequently, do not feel enthusiastic about it, as explained below.

This first emotional response is followed by the description of three sensory attributes that we consider most important to explain the different styles of wine smell.

Intensity

The intensity is easily measured by the distance from the nose to the glass when aromas first begin to be noticed, prior to swirling the glass. The tasters may perceive that intense wines can be

smelled with the nose a few centimetres above the glass border while, for the low odor impact wines, the nose must be put in the glass bulb. The differences in intensity should be confirmed after swirling the glass. With this relatively objective attribute, both neophytes and experts tend to share the same evaluation. In contrast, the next two attributes, required to understand the type of wine intensity, are more difficult to perceive.

Elegance

The definition of elegance is not easy and is usually disregarded in scientific publications. In a divulgation textbook M. Broadbent [35] describes an "elegant" wine as one possessing "stylish balance and refined quality." Here, we propose to understand elegance as an attribute varying from "cloying" to "subtle". The expression "cloying" or "ostensive" typifies the intense "sweet" smell that is characteristic of many wines that remind flowers or tropical fruits. The easiest way to correctly interpret "cloying" is to imagine smelling and drinking such a wine every day for a fortnight. A cloying wine rapidly becomes tiresome and sickening, as it would in the case of many highly aromatic wines such as Muscat, Gewürztraminer, Sauvignon Blanc, or even Riesling. Red wines with a cloying smell are produced by over-ripe grapes, a smell that reminds one of raisins or jams, typical of warm winemaking regions. Classic examples of this type of smell are the many New World and Southern European wines whose aging in oak wood (often exaggerated) confers upon them a flamboyant style that is pleasing to amateurs. "Subtle" is the opposite of cloying/ostensive and is frequently associated with wines that have a delicate bouquet, something that makes little impression on amateurs but is impactful to experts. The latter acknowledge that the smell of the great white Chablis and Burgundy wines is subtle whilst at the same time, sophisticated and challenging, explaining why these wines are said to have a "distinct bouquet", even when very young. The reason for such an attribution, which surprises amateurs, is that the experts understand that these wines will develop as they age in bottle and over time, their aromas will increase in intensity and complexity. Cool climate whites such as Pouilly Fumé, Sancerre, the Austrian Grüner Veltliner, or the Azorian Verdelho are other examples of wines of this style.

Complexity

The notion of a "complex" contrasts to a wine that is "easy". An "easy" to describe wine is typical of fragrant wines where the primary odors of aromatic varieties stand out, often due to the presence of a single chemical compound, as with linalool in Muscat. Most tasters easily identify these smells and are able to guess or to recognize the right descriptor. Occasionally, winemakers make these wines more commercial by flavoring them with oak chips, as is the case of many New World Chardonnays, and this confuses amateurs who appraise them as though they were complex wines. The olfactory representations of complexity to describe wine's aging bouquet by wine professionals tended to highlight a pool of seven main aromatic notes: undergrowth, truffle, toasted, spicy, liquorice, mint, and fresh red- and black-berry fruits [37]. However, the recognition of many odorants is not achievable by consumers. Therefore, we adopted the definition of Melcher and Schooler [38] who defined stimulus complexity in terms of the difficulty of capturing the stimulus in words, that is, complex wines are harder to verbalize. Thus, the maximum complexity is given to an aroma that is "difficult" to describe such as is the case of the aforementioned Chablis and Burgundy. Red wines with a distinct bouquet are, like those white wines, associated with a weak aromatic intensity and the almost total absence of fruity notes. Classic examples of this type of smell are some young wines, such as Cabernet Franc from the Loire Valley, Tinta Mencia from Ribeira Sacra, some Cabernet Sauvignon from cool climate regions, such as New Zealand, and the American states of Oregon and Washington, the Barolo and Barbaresco from Alba in the Piedmont, and the Portuguese bottle-aged reds from the Dão.

Our experience also enabled us to have an additional simple measure of complex wines. When large numbers of tasters are present, complex wines give rise to a higher number of descriptors. This diversity is welcome and agreement in aroma identification among individuals is not needed.

In fact, aromas are perceived and verbalized differently [19,39,40] and the appreciation of such diversity builds agreement between neophytes and the experts.

Expectations for the Mouth

The previous steps can be performed quickly, and it becomes easier to describe the second emotional response, described as "expectations for the mouth". Most likely, there will be a marked difference between beginners and experts as the former will likely have high expectations from a highly aromatic simple wine, whereas the latter would have high expectations from wines with a subtle complex smell.

4.3.2. Mouth Evaluation

Relation to the Expectation Given by the Smell

The wines are described as "disappointing" when the wine "smells more than it tastes" or "exciting" when it "tastes more than it smells". This emotional reaction usually provides a benchmark for beginners who become immediately aware whether they are disappointed when they taste the wines they initially preferred or agreeably surprised with the wines they had first disliked. In this manner, when they taste two anchor wines of opposite styles sequentially, they internalize the characteristics of each one and establish the extreme values of a mental scale that enables them to typify every variation that falls in between.

The purpose of the following sensory descriptors is to explain the previous emotional responses.

Thermal Sensation

The thermal sensation that wines produce in the mouth has little to do with the temperature of the wine as one is always supposed to taste wines at the same temperature. In the tasting sheet, this ranges from "cool", basically a result of the fixed acids in the wine, to "hot", the warmth the alcohol and sugar produce in the mucosa [21,41].

Creaminess

Creaminess is a characteristic associated to the tactile sensation of texture frequently mentioned as gooey, sticky, fatty, or oily. In the tasting sheet, it ranges from "dry" to "jammy". The best-known jammy wines are whites that are fermented in casks and subjected to long periods of contact with the fermentation yeasts (bâtonnage sur lies), so that the high molecular weight compounds, including proteins and polysaccharides, that are released from the cells to the wine, increase the wine viscosity and produce the jamminess [42]. Viscous mouth-feel may also be an equivalent descriptor and Runnebaum *et al.* [43] discarded its relation with ethanol and glycerol in white wines, and associated it with spice, oak, and caramel of barrique-aged wines. The most famous example of highly creamy wines is the Muscadet sur lies. In the case of red wines, bâtonnage does not work and traces of sugar and/or glycerol may be added to increase their creaminess.

Fullness

Fullness is closely associated to subjective notions of weight, volume, structure, power, amplitude, density, viscosity, and so forth [44,45]. In the tasting sheet, the sensation that is created on the palate is described as ranging from "light" to "full-bodied". As this is normally more important in the case of red rather than white wine, on the tasting sheet we indicate that it should only be employed for red wines. Still, sweet or fairly sweet white wines, especially those that are woody, may produce a sensation of fullness in the mouth that cannot be ignored.

Harshness

Harshness corresponds to the mouth sensation of astringency is essentially caused by the non-volatile phenolic compounds in the wine and they are present in much greater quantity in red than in white wine [46]. The enormous variety of these compounds in red wine has not made it possible, so far, to determine just how much each contributes to the sensation of harshness, although it is believed that all do so, especially tannins which are well-known polymers of these compounds [47]. The low polyphenol content in white wine makes any assessment of harshness in the mouth irrelevant, which is why this parameter is only examined for red wine. Beginners, with their untrained palates, find harshness unpleasant and leads them to penalize harsh wines. Connoisseurs, on the other hand, do not usually do so as they know that this is a characteristic of the wine and that it will diminish or disappear with time and, furthermore, that it is an essential characteristic of a wine that one wishes to serve especially with fatty food.

Dry, rough, and harsh were the terms used more often by consumers to describe astringency [48] and we decided to use harshness as the descriptor. In the tasting sheet this description ranges from "soft", wines that create no roughness in the mouth, to "abrasive", young, tannic. The serial tasting of several harsh wines has a cumulative effect in the mouth that penalizes the last wines that are tasted as these will appear to be more abrasive than they actually are.

Persistence/Finish

Persistence ranges from a "short" presence in the mouth to a "long-lasting" presence, and it is equally important in both red and white wines [33]. In white wines, this is directly related to the acidity of the wine, which is why some acid wines give cool thermal sensations and "taste more than they smell". For the same reason, wines that are low in acid are invariably short-lasting, even if they have had a great impact in the mouth, as is the case with very woody, very alcoholic whites, giving hot thermal sensations. Persistence in the mouth is also directly related to acidity in red wines. This can, however, also be caused by the harshness/bitterness of a wine, although the effect is different from the acidity as, instead of producing a long and pleasant finish, the finish is aggressive and occasionally unpleasant. This is what happens with young, very tannic red wines from cool regions, where the mouth remains astringent for a long time and only appropriate food can diminish this sensation.

Prevailing Flavors

The next step is the examination of the "prevailing flavors", which we feel is of great importance not only because it is used for identifying the style of the wine but, mainly, because as it shapes the tasters' preferences, it is a decisive emotional component. The two most important and frequent taste sensations are sweet and acid, although in some wines, salty or bitter may predominate slightly. The perception of the prevalence of sweet in wines, so pleasing to novices, results from the predominance of sweet or fairly sweet components of the wine, basically sugar, ethanol, glycerol, and floral, fruity and woody aromas that prevail over acid, and bitter components, namely acids, acid salts, and polyphenols. Thus, many wines with no residual sugar, either red or white, may lead the taster to perceive sweetness, not just because of the qualities of the aromas that are present, as in the case of highly aromatic varietals (Muscat, Gewürztraminer, Sauvignon Blanc, Alvarinho), but also because of the high alcohol and/or the lack of acidity, such as is the case with warm region wines. The intensity and the type of aromas produced by the retronasal olfaction also contribute to decreased astringency and bitterness and increase the sweet perception mainly in white wines [49].

The perception of the prevalence of acid contrasts with sweet, as acid, and occasionally bitter, compounds predominate over the compounds that are responsible for sweetness, both in red and white wines; this occurs in wines from cool regions produced from varietals that are not very aromatic. Chablis and Cabernet Franc in the Loire Valley are classic examples of this. The prevalence of harsh/bitter only occurs in red wines and is due to the presence of high amounts of bitter and/or harsh phenolic

compounds that are not present in noticeable amounts in white wines. When the wines are produced in cool regions, the perception of harshness is enhanced by the high acidity and produces aggressive wines and when the wines are produced in hot regions from highly aromatic varietals, this perception is very indistinct. A predominant perception of salty is very rare but it might occur in old wines, both red and white, where the high acidity and harshness they exhibited when young were "softened" as they aged in the bottle, as is the case with an old Burgundy or with a Colares wine from Portugal.

The perception of tastes, as with aromas, is dependent on the individual [50,51], and so diverse reactions to the same tastes are expected when a large number of tasters is present.

4.3.3. Final Olfactory Evaluation

Evolution and Duration of the Fragrance in the Glass

The next stage in the tasting sheet is the "final olfactory assessment". Now, the taster is asked to assess two aromatic features that will help him identify the style of the wine and, principally, to understand the different rhythms that a wine expresses: the "evolution of the fragrance in the glass" and "duration of the fragrance in the glass". In the case of the majority of full-bodied wines, both red and white, there is almost always only a very minor change of the fragrance in the glass, as these wines are created so that the full extent of their aromas present as they are poured. On the other hand, wines with a subtle bouquet, especially those that have aged for some time in bottle, usually improve greatly in the glass thanks to the effect of the oxygenation and rise in temperature. Due to this, their fragrance develops at a slower pace that must be recognized. Unfortunately, this does not often happen. In some cases, this may be attributed to a lack of knowledge, as with most beginners while, in other cases, such as in wine competitions, the vast number of samples to be tasted does not allow sufficient time for "slower" wines to develop. Although the "duration of the fragrance in the glass" is a detail that adds little to the general impression left by the earlier steps in the tasting, it is very useful for identifying so-called "technological" wines in which aromatic exuberance is rapidly lost, sometimes in less than an hour.

4.3.4. Overall Evaluation

Overall Perception

The final overall perception varies from "disagreeable" to "exciting", and it represents the final conclusion of the taster's evaluation, conditioned by training and his preferences, to all the sensations he has experienced throughout the tasting. It is, therefore, a highly emotional conclusion.

4.3.5. Visual Assessment

Lastly, the taster should now pay attention to the color and clarity of the wine and assess these characteristics, something that his eyes will do with some ease with a little practice and knowledge of the respective vocabulary. At this stage in the tasting, the visual examination of the wine will no longer influence his overall impression of the wine as it would have had this evaluation occurred at the start of the evaluation process.

4.4. Wines

The choice of the anchor wines for the training sessions is critical for the success of the approach. The "difficult" and "easy" wines of the first sessions must have clearly opposite sensory attributes, as shown in Table 3, so as most tasters agree on the overall description.

The differences between the wines may not be so sharp in the subsequent sessions but tasting always includes wines of opposite styles. We tasted all wines previously to separate them between "easy" and "difficult" but tasters were not aware of this distinction. We obtained the so-called "easy" wines mostly from Portuguese successful commercial brands from warmer regions (Palmela, Terras do Sado, Alentejo, Tejo, Lisboa, low altitude Douro) and some have been awarded in international wine

challenges. Difficult wines included Chablis and Burgundy because of their worldwide recognized fame and quality (1st cru grade) but that usually are not awarded when tasted blind. The "difficult" Portuguese wines were mostly chosen by comparison with those French wines from cooler regions (Bairrada, Dão, Beira Interior, high altitude Douro, Pico).

All wines used in this study were commercial 0.75 L bottles obtained at local retail stores or directly at wineries. The wines are listed and briefly characterized in Table 4.

Table 3. Characteristics of the two opposite anchor wine styles used in the training sessions.

Features	"Easy" Wines		"Difficult" Wines	
	White	**Red**	**White**	**Red**
Color	Light yellow	Deep red	Yellow green or straw	Light or deep red
Limpidity	Limpid	Limpid	Limpid	Limpid
Smell intensity	High	High	Low	Low
Dominant smell	Flowery and/or fruity	Black and overripe fruit	Difficult to define, initially is reduced	Difficult to define, initially is reduced
Smell evolution	Absent	Absent	Changes favorably, reductive odors disappear	Changes favorably, reductive odors disappear
Dominant taste	Sweetish	Sweetish	Acid	Acid
Mouth-feel	Smooth	Smooth	Aggressive due to acidity	Aggressive due to astringency and acidity
Persistence	Low	Low	High	High

Table 4. Wines used in the 2012 and 2014 tasting panels.

Tasting Date	Wine	Denomination	Vintage	Description
2012 Tastings				
03-10-2012	WE1 [a]	DOC [b] Palmela	2011	White, blend dominated by Muscat, low acidity, short persistence Gold Medal, Concours Mondial de Bruxelles 2012
03-10-2012	WD1	DOC Douro	2008	White, Malvasia Fina, yellow-straw color, low flavor, long mouth-feel
10-10-2012	RE2	DOC Alentejo	2011	Red, Syrah and Aragonês/Tempranillo, intense red, jammy notes, full-bodied
10-10-2012	RD2	Burgundy, Saint Aubin	2005	Red, Pinot Noir, 1st Cru, light color, discrete complex smell, persistent mouth-feel
10-10-2012	WE3	DOC Tejo	2011	White, blend, 40% aged in barrique, intense red, full-bodied, jammy flavours Silver Medal, International Wine Challenge 2012
10-10-2012	WD3	AOC [c] Chablis	2006	White, Chardonnay, discrete and complex aroma, long persistence in the mouth
17-10-2012	WE4	Regional Lisboa	2011	White, blend dominated by Fernão Pires, highly aromatic, sweet and short mouth-feel
17-10-2012	WD4	DOC Dão	2010	White, Encruzado, 10% aged in barrique, low smell intensity, complex flavors, long aftertaste
24-10-2012	WDa5	DOC Douro	2009	White, Viosinho, yellow straw color, discrete smell, long mouth-feel
24-10-2012	WE5	DOC Douro	2011	White, blend dominated by Muscat, highly aromatic, sweet and short aftertaste Silver medal, Decanter World Wine Awards 2012
24-10-2012	WDb5	DOC Bairrada	2010	White, Chardonnay, low flavor, long aftertaste
07-11-2012	WE5	DOC Beira Interior	2010	White, Síria, fruity and flowery smells, medium mouth persistence
07-11-2012	WD6	DOC Bairrada	2009	White, blend, low flavor, sour and long aftertaste
14-11-2012	RE7	DOC Dão	2010	Red, Touriga Nacional, barrique aged, red fruity smell, evident oak, medium mouth persistence
14-11-2012	RD7	DOC Douro	2010	Red, blend, low intensity flavor, long mouth persistence

Table 4. *Cont.*

Tasting Date	Wine	Denomination	Vintage	Description
		2014 Tastings		
02-04-2014	WE1	DOC Lisboa	2013	White, Alvarinho, yellow-green color, highly aromatic, sweet and medium long mouth-feel Gold medal, Mundus Vini 2013
02-04-2014	WD1a	DOC Douro	2004	White, Rabigato, yellow-straw color, low vegetal smell, aging notes, long mouth persistence
02-04-2014	WD1b	DOC Douro	2012	White, Viosinho, discrete complex flavor, long mouth persistence
03-04-2014	REa2	DOC Lisboa	2008	Red, Pinot Noir, Touriga Nacional, barrique aged, jammy and straw flavors, sweet and short mouth-feel Gold medal, China Wine and Spirits Awards 2013
03-04-2014	REb2	DOC Alentejo	2009	Red, Syrah, Viognier, barrique aged, black fruit and jammy flavors, sweet and short mouth-feel Commended, International Wine Challenge 2012
03-04-2014	RD2	AOC Beaujolais Village	2011	Red, Gammay, light red color, red fruit flavors, sour and long mouth-feel
04-04-2014	WEa3	DOC Alentejo	2011	White, Viognier, barrique aged, vanilla dominated flavors, buttery full and short mouth-feel Bronze medal, Decanter World Wine Awards 2014
04-04-2014	WEb3	Regional Terras do Sado	2012	White, Muscat, highly aromatic, seet and short mouth-feel
04-04-2014	WD3	DOC Beira Interior	2011	White, Chardonnay, discrete flavors, long mouth persistence
14-05-2014	RD4	DOC Lisboa	2008	Red, blend, initially reduced flavors, aged character, long mouth-feel
14-05-2014	RE4	Regional Alentejo	2012	Red, Reserva, blend, jammy flavors, short mouth-feel Gold medal, Mundus Vini 2014
19-05-2014	RD5	AOC Burgundy	2011	Red, Pinot Noir, light red color, low intensity smell, rough and long mouth-feel
19-05-2014	RE5	DOC Alentejo	2011	Red, Touriga Nacional, deep red color, intense jammy flavors, short mouth-feel
21-05-2014	WD6	AOC Bordeaux	2012	White, Sauvignon Blanc, Muscadelle, low flavored, long mouth-feel
21-05-2014	WE6	DOC Lisboa	2013	White, Sauvignon Blanc, highly aromatic, medium mouth persistence
23-05-2014	WE7	DOC Palmela	2013	White, Fernão Pires, highly aromatic, short mouth-feel
23-05-2014	WD7	DOC Pico	2011	White, blend, low flavor, acid and long mouth-feel
23-05-2014	RE8	DOC Alentejo	2012	Red, blend, black fruits, jammy flavors, sweet and short mouth-feel Commended, Decanter World Wine Awards 2014
23-05-2014	RD8	DOC Douro	2010	Red, Reserve, blend, red fruits, vegetal flavors, long finish
26-05-2014	RD9	DOC Beira Interior	2006	Red, Reserve, blend, vegetal and aged flavors, long finish
26-05-2014	RE9	DOC Lisboa	2009	Red, Reserve, Blend, Barrique, oak dominating flavors, sweet and short mouth-feel Cellar Selection, Wine Enthusiast 2013
27-05-2014	WD10	Chablis	2011	White, Chardonnay, 1st Cru, initially reduced smell, low intensity flavors, long aftertaste
27-05-2014	WE10	DOC Alentejo	2011	White, Reserve, Viognier, Arinto, intense aroma, sweet and full mouth-feel
28-05-2014	RE11	Regional Lisboa	2012	Red, blend, intense jammy flavors, sweet and short mouth-feel Gold medal, China Best Value Wine & Spirits Awards, 2014
28-05-2014	RD11	DOC Bairrada	1997	Red, Reserve, Baga, red-brick color, reduced flavors, complex aged character, acid and long aftertaste

[a] Wine reference: W (white), R (red), E (easy), D (difficult), followed by sample number; [b] DOC: Denomination of Controlled Origin; [c] AOC: Appelation d'Origine Controllé.

Abbreviations

The following abbreviations are used in this manuscript:

AOC	Appelation d'Origine Controllé
DA	Descriptive Analysis
DOC	Denomination of Controlled Origin
OIV	International Office of Vine and Wine

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