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RUNNING HEAD: ROSÉ-COLOURED GLASSES

Drinking through rosé-coloured glasses: Influence of wine colour
on the perception of aroma and flavour in wine experts and novices

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ABSTRACT

24 Wine colour carries a myriad of meanings regarding the provenance and expected
25 sensory qualities of a wine. That meaning is presumably learnt through association, and
26 part of a wine taster's skill comes from being able to decode information that can be
27 discerned in subtle variations in the colour of the wine that they drink/evaluate.
28 However, reliance on colour means that wine tasters, especially experts, often exhibit
29 colour-induced olfactory biases. The present study assesses how wine colour –
30 specifically the pink hue of rosé wines – can influence both the perceived aroma and
31 flavour in a large sample of wine novices and experts. Participants (N=168) tasted three
32 wines – a white wine (W), a rosé wine (R), and the white wine dyed to match the rosé
33 (R') – and freely selected three aroma and three flavour descriptors from a list. They
34 also rated wine liking, flavour intensity, and description difficulty for each wine.
35 Linguistic analysis demonstrated that those with wine tasting experience judged R' to
36 be much more similar to R than to W, even though R' and W were the same. Moreover,
37 red fruit descriptors were attributed to both R and R', especially in terms of flavour.
38 Quantitative ratings revealed that R' was liked less than W or R, and participants found
39 it more difficult to describe R' than R. These results demonstrate that while participants
40 found the dyed rosé somehow different from the undyed wines, they nevertheless used
41 the red fruit terms to describe its aroma and flavour. The implications of such results in
42 terms of cognitive representations of wine and the role of sensory expectations are
43 discussed.

44

45 **KEYWORDS:** Colour-Induced Olfactory Bias; Colour; Associative Learning;
46 Expectations; Wine Aroma; Wine Flavour; Wine Expertise

47 **1. Introduction**

48 Wines come in many colours: everything from the golden yellows of a Sauternes to the
49 dark browns of a Malmsey, from the brick reds of a mature claret to the deep purples
50 of a young Napa Cab or Argentine Malbec, and from the clear appearance of ‘water
51 white’ Vinho Verdes through to the blackish-red sweet PX (Pedro Ximénez) wines
52 from Andalucia. These shades of colour carry meaning for both the professional wine
53 taster and sometimes also for the social drinker (Spence, 2010b). That meaning is
54 presumably primarily learnt through association, and at least a part of a wine taster’s
55 skills comes from being able to decode the information that subtle variations in a wine’s
56 hue, clarity, and brilliance hold.

57

58 Wine tasters tend to focus on the colour, intensity, and clarity of a wine when evaluating
59 its visual appearance. Emile Peynaud (1987, p. 31) talks of a wine’s limpidity (dullness,
60 brilliance) and colour (intensity and shade). Intensity is described in terms of simple
61 adjectives such as pale, light, and weak at one end through to deep, dark, and intense at
62 the other. To the knowing taster, intensity can indicate climatic conditions – with
63 warmer years and warmer regions producing wines with deeper intensity; age – white
64 wines pick up a deeper colour as they age, whereas red wines go paler; and grape variety
65 – where thicker-skinned red grapes tend to produce deeper wines (Schuster, 2002). The
66 shade of colour itself can also play a role: for instance, a bright blue hue in a red wine
67 might indicate its youthfulness, whereas mature reds tend to take on garnet and tawny
68 hues (Fielden, 2009). By relying on colour, a knowledgeable taster can therefore cut
69 down on the cognitive load that would otherwise result if every wine sample were
70 analysed only based on its chemosensory properties (Gawel, 1997). As such, colour
71 cues can be used to facilitate information-processing analysis in classifying a wine
72 sample (in fact, trained beer tasters also rely on colour to categorise beers, see Lelièvre
73 et al., 2009).

74

75 Over time, the experienced wine taster can build up associations between wine colour
76 and the correlated structure of aromas and flavours to be stored in semantic memory
77 (e.g., Brochet & Dubourdieu, 2001, although there also exist associations between some
78 wine odors and colors in social drinkers, see Heatherly et al., 2019). After all, robust
79 colour-taste associations (such as the association between the colour red and sweetness)

80 has been well-known in sensory science over the last 80 years (see Spence, 2019, for a
81 recent review), with such associations driven by repeated associations (Higgins &
82 Hayes, 2019) as well as emotional valence (Saluja & Stevenson, 2018). These
83 associations, while typically useful, can also be disruptive when visual cues bias
84 sensory perception, especially as colour characteristics can be independent of wine
85 quality and typicality (Valentin et al., 2016). In fruit-flavoured beverages, manipulating
86 product colour has been shown to alter product identification (Dubose, 1980; Zampini
87 et al., 2007, 2008) and reported taste intensity (Clydesdale et al., 1993; Huang et al.,
88 2019; Lavin & Lawless, 1998; Pangborn & Hansen, 1963; see Spence, Levitan,
89 Shankar, & Zampini, 2010, for a review). In some of the earliest research on the colour
90 of wine, Pangborn et al. (1963) found that when given the same white wine dyed in an
91 array of colours – yellow, brown, pink, red, and purple – experts attributed the greatest
92 sweetness to the pink-coloured wine. The authors posited that the sweetness association
93 might have been attributable to the experts' familiarity with sweet rosé wines popular
94 during that era. More recently, Sugrue and Dando (2018) reported that both the colour
95 of the product as well as its packaging can influence the perceived taste, mouthfeel, and
96 temperature of cider, with red coloured labelling making the cider seem sweeter and
97 fruitier. Even changes to ambient room colour have also been shown to influence wine
98 judgments, even when people are tasting from black tasting glasses (Oberfeld, Hecht,
99 Allendorf, & Wickelmaier, 2009; Spence, Velasco, & Knoeferle, 2014). For
100 consumers, colour can serve as an important predictor of food acceptance (Spence,
101 2018), preference (Pokorny et al., 1998), and even consumption quantity (König &
102 Rennber, 2018).

103 Colour-induced olfactory bias is well-documented in the world of wine. In one oft-cited
104 study, Morrot, Brochet, and Dubourdieu (2001) had a group of first year oenology
105 students draw-up a list of descriptors for both a red and a white wine. One week later,
106 the students were again given a glass of red wine and a glass of white wine, and were
107 asked to match each wine to each of the descriptors they had produced the previous
108 week. Unbeknownst to the students, the two wines from the second week were actually
109 the same – the red wine was the same white wine that had been artificially coloured red
110 with odourless dye (anthocyanin). However, the results revealed that the red wine
111 descriptors were much more frequently attributed to the fake red wine rather than the
112 white wine.

Parr et al. (2003) performed a follow-up study in New Zealand, in which they tested both experts (including professional wine tasters and wine makers) and social drinkers. The descriptions of the aroma of a chardonnay wine given by experts when it had been artificially coloured red were more accurate when the wine was served in an opaque glass than when served in a clear glass instead. Interestingly, this colour-induced biasing of aroma judgments occurred even though the experts had been explicitly instructed to ignore the colour of the wines that they had been instructed to taste. In this case, the social drinkers were so poor at reliably identifying the aromas present in the wine that it was difficult for Parr et al. to discern any pattern in the data when an inappropriate colour was added to the wine.

It should be noted that the studies described above involved only white and red wines. Rosé wines fall somewhere between white and red wines, being a red wine produced using the same winemaking methods as white wines (Fielden, 2009). Instead of leaving the must to macerate with the skins for days or even months, rosé wines see much shorter skin contact – on the order of hours – which explains their delicate colour. Rosé wines are also notoriously difficult to describe in terms of their aroma. Ballester et al. (2009) conducted a study in which groups of wine experts, novices, and trained panellists were given red, white, and rosé wines in opaque tasting glasses to smell and categorise as “red”, “white”, and “rosé” wines. As it turned out, all were able to categorise the white and red wines accurately, but not the rosé wines. The importance of colour on aroma categorisation is shown in an intriguing study involving early-blind individuals compared to blind-folded normal subjects in tasks that involve strong visual mental categorisation (Manescu et al., 2018). In a range of wine odour evaluation tasks involving red, white, and rosé wines, the researchers found that blind individuals performed worse than normal participants in terms of odour categorisation (determining whether two wines belong to the same category of red/ white/rosé), but there were no differences in odour differentiation or classification tasks. The researchers concluded that the blind group had performed worse as their blindness prevented them from learning and constructing internal categories based on visual mental representations. This result therefore provides support for stronger associations between visual-olfactory processing compared to verbal-olfactory processing.

In fact, it could be argued that colour is a more important aspect of a rosé wine’s identity compared to white or red wines. Coulon-Leroy et al. (2018) recently examined role of

colour in the typicality assessment of the famously pale Provençale rosé wines. The researchers concluded that colour is the major determinant of typicality, especially as there is no one single sensory profile of a typical Provence rosé. Therefore, we believe that manipulating the colour of rosé wines should result in significant olfactory and flavour biases.

1.1 Aims and contributions

The primary aim of the present study is to assess how wine colour can influence the perceived aroma and flavour in white and rosé wines. We had a unique opportunity at science and wine symposium to gather a large sample of participants of various wine expertise levels, which made it possible for the present study to have a much larger sample size than previous studies (N=168, compared to 54 in Morrot et al. (2001) and 52 in Parr et al. (2003)). Besides sample size, the present study differs from previous research in this area in three key ways: 1) Both orthonasal aroma and flavour are measured. This is different from previous studies (Morrot et al., 2001; Parr et al., 2003) where only orthonasal aroma was recorded. This is important because one cannot assume that a colour's effect on orthonasal olfactory judgments of food/drink flavour will necessarily be the same when people come to actually taste the food or drink item (Spence & Piqueras-Fiszman, 2016, p. 115; see also Koza et al., 2005).

2) Linguistic analysis with freely selected descriptors. In previous work (Morrot et al., 2001; Parr et al., 2003), participants were first asked to create a canonical list of descriptors by smelling a red wine and a white wine, then rating the extent to which each descriptor from the list that they had generated best fit the samples that followed. In the present study, the participants were allowed to freely select descriptors for all three wines independently, without being constrained to think about a fixed set of descriptors.

3) Instead of only showing the same wine twice (with and without added colour), the present study involves three wines – a white wine (W), a rosé wine (R), and the same white wine coloured to match the rosé wine (R'). This adds a novel point of comparison – we can compare how similar R is to W and to R'. Even though R' and W are the same wine, we would expect participants to find R more similar to R' than to W. Moreover, we decided to use rosé wines instead of red wines to make the comparison more

naturalistic for the participants. Compared to red wines, white wines and rosé wines typically have more similar mouthfeel due to their low tannin content (Schuster, 2002). Therefore, by comparing white wines and rosé wines, we minimised the chance that the wines could be distinguished based on mouthfeel alone when participants tasted the wines (beyond just smelling them orthonasally, as in previous studies).

We hypothesised that for both orthonasal aroma and flavour, the white wine (W) and the fake rosé (R') would be associated with different descriptors even though they are the same wine. Conversely, the real rosé (R) and R' would share more descriptors than R' and W, even though R' and W are, in fact, the same. Finally, given the tendency for experts to experience colour-induced bias (Parr et al., 2003), we would expect experts to judge R and R' to be more similar, compared to the less experienced participants.

2. Materials and methods

2.1 Participants

A total of 168 participants (76 women, 85 men, 7 did not respond) took part in this study, which took place at a Neuroscience and Wine symposium in Barcelona, Spain. The audience were informed that they could volunteer to take part in a series of wine-related experiments, without any further detail being given about the manipulations involved. 44 participants were in the 18-35 years age group, 118 in the 35-60 years age group, and 2 in the 60 years or above age group (5 unreported). The participants self-reported their level of wine expertise, with 22 beginners (defined as "I drink socially but don't know much about wine"), 62 intermediates (defined as "I know which wines I like and have been to some classes"), 79 experts (defined as "I work in the wine trade and/or have 5+ years experience tasting wine formally"), and 5 unreported. All of the participants gave their informed consent to take part in the study. None of the participants reported a cold nor any other known impairment of their sense of smell, taste, or hearing at the time of the study. The study was approved by the Central University Research Ethics Committee of Oxford University (MSD-IDREC-C1-2014-205).

2.2 Wine

The white wine used in the study was Raimat Ventada 2017, made from the Garnacha Blanca (Grenache Blanc) grape from Catalunya D.O. The rosé wine, Raimat Rosada 2017, was produced by the same winery (Raimat), using Cabernet Sauvignon and Tempranillo grapes from Costers del Segre D.O. (see Table 1 for technical information regarding both wines). The wines had similar levels of alcohol by volume and similar pH. While the rosé has more residual sugar than the white wine (4.5 g/L versus 1.5 g/L), both fell into the dry wine category, where up to 9 g/L of residual sugar is allowed given that total acidity is not more than 2 grams below the residual sugar content (EU regulation 753/2002, Article 16 1a). Both wines were selected from the range available from Raimat winery, who was a sponsor of the Neuroscience and Wine Symposium where the study took place.

< INSERT TABLE 1 ABOUT HERE >

Tesco brand red food colouring was used to dye the white wine a pink shade to match the rosé wine. After some experimentation, it was determined that 0.046 g of food colouring / 100 mL wine was an appropriate ratio (see Figure 1). Spectrophotometer (SHIMADZU MPS-2000) measurements of colour absorbance were recorded for each wine sample at 420 nm (yellow), 520 nm (red), and 620 nm (blue) according to the Glories Method (Glories, 1984; Zoecklein et al., 1995) in a 10 mm path-length quartz cuvette against a de-ionised water blank. The data reported in Table 2 show that there were obvious differences in colour between the white and pink-coloured wine samples. The dyed rosé, while not exactly equal to the colour of the actual rosé wine, was similar in colour parameters as measured by instrumental analysis.

< INSERT TABLE 2 ABOUT HERE >

In order to verify that the red dye used in the study had no perceptible odour or flavour, a pilot study was carried out, consisting of a series of triangle tests¹ in which coloured white wine was compared to normal white wine. Participants were blindfolded and tasted triplicates of 10 mL samples in plastic glasses. The results revealed that participants were unable to discriminate the white wine from the pink-coloured white wine under these conditions.

¹ Given the small sample size, it is possible that the triangle test serves only as a validation against large taste differences and may not be able to discriminate between smaller differences between the wines.

The wines were all opened an hour prior to the start of the study, with the dye added to half of the white wine bottles to create the fake rosé samples. All the bottles were then re-capped (they were all sealed by screw cap) and chilled at 5°C until service time, where all the glasses of wine were pre-poured in a separate room (out of sight from the participants).



Figure 1. Top left: artificially dyed rosé, top right: actual rosé. Bottom: in-situ image from the study, with the fake rosé on the left, rosé in the middle, and white wine on the right.

2.3 Design and Procedure

The study was designed with wine colour (white, rosé, fake rosé) as the within-participant factor. Each participant was seated at a table with a paper questionnaire, a bottle of water, and three glasses of wine ordered from left to right. Half of the participants received the white wine, rosé wine, and the fake rosé wine (left to right). The remainder of the participants received the rosé wine, white wine, and fake rosé wine (left to right). No information was provided to the participants concerning the wines, nor the purpose of the experiment, prior to the start of the study. All the participants took part at the study at the same time in the same lecture room.

First, the participants were asked to smell the wines in order, without tasting. After smelling each wine, the participants were asked to write down three aromas that they found to best describe the wine, from a table of 30 descriptors (see Table 3) taken from the WSET Level 3 Systematic Approach to Wine Tasting. The table of descriptors was grouped in rows by category (e.g., floral, citrus, red fruits). It was explained to the participants at the start of the experiment that although the descriptor table was organised in rows they were free to choose descriptors from any of the rows, and could choose multiple descriptors from the same row should they so desire.

Next, the participants were instructed to taste the wines in order. Again, after tasting each wine, they were told to write down three flavours that best described the wine, from the same table of descriptors (see Table 3). For each wine, they also rated on 9-point scales how much they liked the wine (1 = hate it, 9 = love it), the wine's flavour intensity (1 = very weak, 9 = very strong), and the difficulty of identifying different flavours in the wine (1 = very easy, 9 = very difficult). They were instructed to rinse their mouths with water between tasting each wine.

< INSERT TABLE 3 ABOUT HERE >

The participants were instructed to perform the study in silence, without talking or consulting with those sitting next to them. The experiment lasted for around 15 minutes and the participants were debriefed afterwards.

2.4 Data Analysis

First, we analysed correlations between wine liking, intensity, and description difficulty. A repeated measures multivariate analysis of variance (RM-MANOVA) was conducted with wine (white, rosé, fake rosé) as the within-participants factor, expertise level (beginner, intermediate, and expert) as the between-participants factor, and liking, intensity, and description difficulty as measures. All post-hoc pairwise comparisons were Bonferroni corrected.

Next, we calculated the frequency that each category of descriptors was attributed to each wine's aroma and flavour. The descriptors were agglomerated based on their category heading (see Appendices A and B for the distribution of all aroma and flavour descriptors selected by participants for all three wines, sorted by participant expertise level). We also calculated cosine similarity of descriptors between each pair of wines.

Note here that cosine similarity is commonly used in information retrieval and text mining to measure how similar two documents are likely to be in terms of their content (Singhal, 2001).

3. Results

To get an overview of how the rating variables are interrelated, Pearson's correlation coefficients were calculated for wine liking, flavour intensity, and description difficulty (see Table 4). The results revealed that liking was positively correlated with flavour intensity, but negatively correlated with the difficulty of describing the wines. Furthermore, intensity was negatively associated with description difficulty. In other words, wines with more flavour intensity were liked more and their flavours were more easily described. In addition, those wines that were difficult to describe were also liked less.

< INSERT TABLE 4 ABOUT HERE >

A RM-MANOVA revealed a main effect of wine type ($F(6,150) = 4.17, p = 0.004$, Wilks' Lambda = 0.88) and expertise ($F(6, 306) = 5.14, p < 0.0005$, Wilks' Lambda = 0.83), but no interaction between the two factors. Follow-up univariate tests revealed that wine type had a significant effect on liking ($F(2,310) = 4.77, p = 0.01, \eta^2 = 0.03$) and difficulty ($F(2,310) = 4.72, p = 0.01, \eta^2 = 0.03$), but not on intensity ($F(2,310) = 2.86, p = 0.06, \eta^2 = 0.02$). Compared to the white and rosé wines, the fake rosé wine was liked less ($p_{WR} = 0.03, p_{RR'} = 0.04$, see Table 5). The participants also found the fake rosé wine significantly more difficult to describe as compared to the actual rosé wine ($p = .01$). This was potentially due to the fact that participants, consciously or otherwise, found the combination of rosé wine colour and white wine flavours somewhat peculiar.

< INSERT TABLE 5 ABOUT HERE >

Furthermore, expertise had a significant effect on description difficulty ($F(2,155) = 11.76, p < 0.0005, \eta^2 = 0.13$), where experts found it easier to describe the wine than beginners and intermediates ($M_{beg} = 6.12, SE = 0.30, M_{int} = 5.39, SE = 0.18, M_{exp} = 4.61, SE = 0.16, p \leq .005$ for both comparisons), as one might have expected. There was no significant effect of expertise on wine liking ($F(2,155) = 1.39, p = 0.25$) or flavour intensity ($F(2,155) = 2.32, p = 0.10$).

Table 6 provides a frequency table of participants' top-most commonly used aroma and flavour descriptors for each wine. Across all participants, the fake rosé wine was more similar to the rosé wine than the white wine for both aroma and flavour. In terms of aroma, both the real and fake rosé wines were assigned floral, strawberry, and rose as the top three most common descriptors. In contrast, the most selected aromas for the white wine were green apple, floral, and pear. When it comes to flavour, green apple and lemon were the most commonly used descriptors for the white wine whereas strawberry and grapefruit were the most often selected for the real and fake rosé wines. Separating the participants by wine expertise level, it becomes clear that only those at intermediate and expert levels used red fruit, specifically strawberry, as a frequent descriptor for both the actual rosé as well as the fake rosé.

< INSERT TABLE 6 ABOUT HERE >

To better analyse participants' selected aroma and flavour descriptors, they were binned according to the broader aroma/flavour categories that they belonged to (i.e., according to which row from the descriptor table they came from). Figure 2 illustrates the distribution of descriptors by wine and by expertise level, indicating which categories of descriptors were selected at above chance level. Looking over all expertise levels, while the white wine did not have red fruit descriptors at above chance levels, both the fake rosé wine and the real rosé wine were associated using an above-chance level of red fruit descriptors. This pattern was true for both smell and flavour descriptors. Moreover, the prevalence of red fruit descriptors in the fake rosé wine was only observed in experts in terms of smell, and in intermediates and experts in terms of flavour.

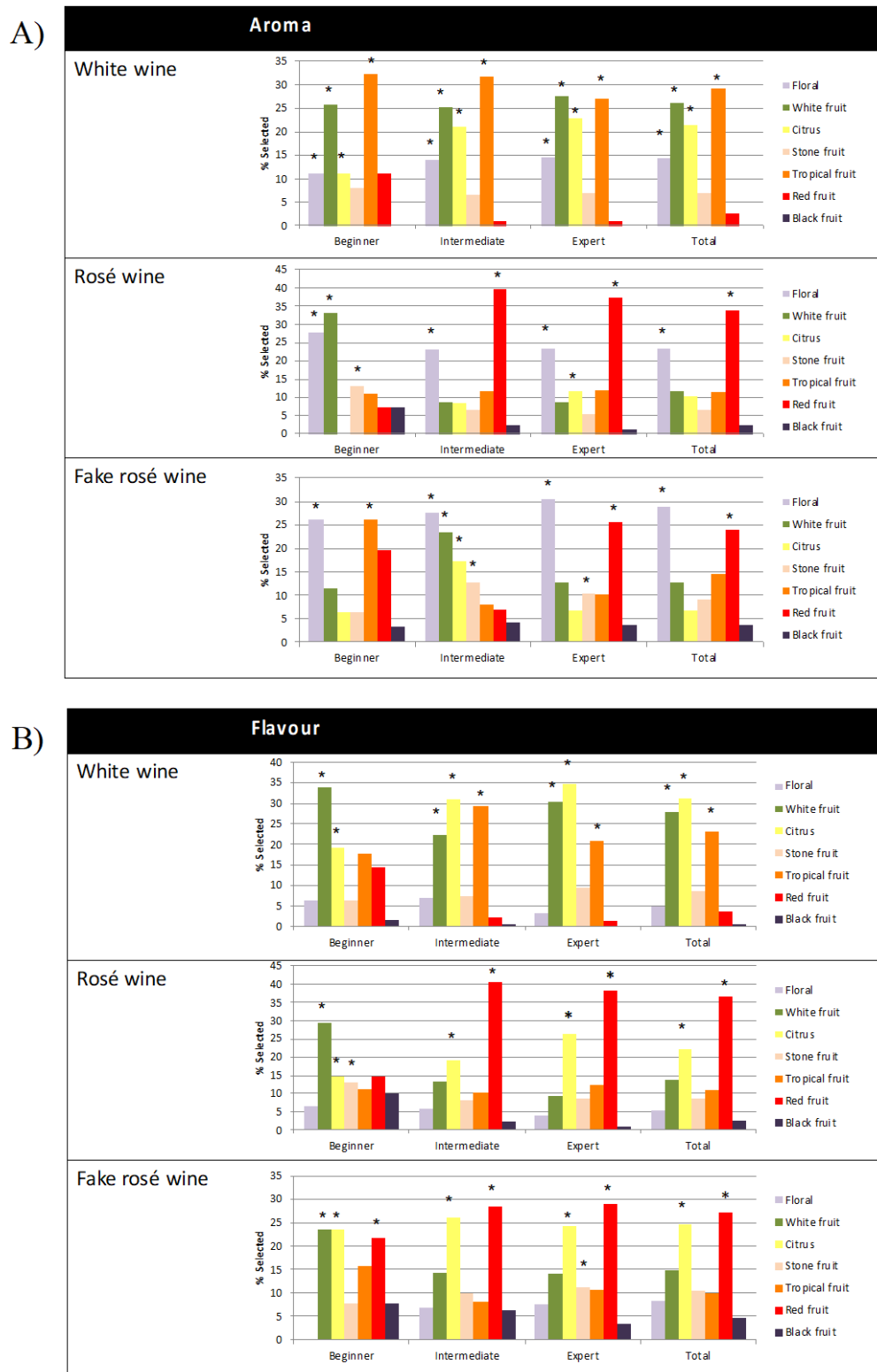


Figure 2. Distribution of A) aroma and B) flavour descriptors for the three wines, sorted by participant expertise level. Note that the right-most column shows the total participant population. Distribution is normalised as the percentage of the total number of descriptors selected for a particular wine and by the particular set of participants. Asterisks indicate where the descriptor group was selected above chance level.

Given the distribution of descriptor categories, a similarity analysis was performed between pairs of wines by calculating cosine similarity. Imagine an N-dimensional space where N = the number of descriptor categories (7 in this case). The distribution of descriptors attributed to each wine can be visualised as a vector in the N-dimensional space. To compare two wines, the cosine of the angle between the two vectors representing the descriptor distribution associated with those wines can be measured (Singhal, 2001). By definition, cosine similarity is constrained between 0 and 1, 0 when the vectors are orthogonal (completely dissimilar) and 1 when the vectors are identical. The calculation was performed using the Document Similarity web application (<http://www.scurtu.it/documentSimilarity.html>). Table 7 shows cosine similarity results for all pairs of wine, supplemented by chi-squared tests of independence based on chosen aroma/flavour descriptors. For all participants, R was rated to be much more similar to R' than W for both aroma and flavour, which fits our hypothesis that colour biased participants wine judgments. Moreover, R and R' is the only pair of wines whose assigned smell and flavour descriptors are not significantly different from each other, further supporting the idea that participants believed the dyed rosé was more similar to the real rosé than to the undyed version of the same wine.

Furthermore, dividing the participants by expertise level, we see from Table 7 that it is only the intermediate and expert participants who rated the R R' pair to be more similar than the R W pair. In other words, as hypothesised, and as illustrated in Figure 2, only those with wine tasting experience were biased by the colour of the wines.

< INSERT TABLE 7 ABOUT HERE >

4. Discussion

The importance of wine colour in shaping what we smell and taste was demonstrated in the present study. The participants assigned descriptors to a white wine, a rosé wine, and the same white wine dyed to match the colour of the rosé wine. When it came to the dyed wine, those participants with wine tasting experience used aroma and flavour descriptors that were more in line with the rosé wine as opposed to the identical but undyed white wine.

As previously proposed by Morrot et al. (2001) and Parr et al. (2003), colour bias reveals top-down information processing in those who have linked wine colours with

associated aromas and flavours through experience (which is one manifestation of wine expertise; see also Spence, 2010a). Brochet and Dubourdieu (2001) hypothesised that the colour of a wine may activate a so-called prototype in the mind of the experienced taster which then predisposes them to look for aromas/flavours associated with the prototypical wine (not to mention any hedonic and technical information regarding the wine). For instance, seeing the pale pink colour of R and R' might have triggered the prototype of a Provençal rosé wine in the mind of the experienced tasters, leading them to expect the associated aromas and flavours of floral and red fruit notes. This may help to explain why R and R' were judged to be so similar even though they were made from different grapes. By the same mechanism, participants might have formed different mental prototypes for W compared to R', just based on their different colours, even though they were the same wine. This would explain the lower similarity scores between W and R', which is in-line with a small-sample study from Sauvageot and Struillou (1997). In the study, participants (N=12) judged pairs of different white wines as more perceptually different (on a continuous scale with "identical" on one end and "different" on the other end) when one wine out of the pair was dyed red, compared to when both wines were undyed.

One method that could have tested this theory would have been to ask the participants for their expectations of aromas and flavours upon seeing the wines (see Reinoso Carvalho et al., 2019, for an example with coloured beers). In a series of studies involving brightly coloured solutions with fruity aromas, Shankar et al. (2010a, b, c), demonstrated that colour influences orthonasal odour identification by shaping people's expectations. Furthermore, the influence of colour was based on the degree of discrepancy between the expected odour and actual odour, with low discrepancy between expected and actual odours (for instance, blueberry-coloured purple to evoke expectations of grape) more likely to result in biased identifications (Shankar et al., 2010b). This result is in-line with the assimilation-contrast model of expectation disconfirmation, where a smaller difference between expected and actual feature is more likely to result in assimilation of the actual experience towards what was expected (Cardello & Sawyer, 1992; Piqueras-Fiszman & Spence, 2015; Schifferstein et al., 1999). In the context of the present study, it is certainly possible that participants had the same expected aromas and flavours for the two pink coloured wines upon visual inspection. Furthermore, the aroma and flavour of the fake rosé – which, after all, was

a young, crisp, and fruity wine (<http://raimat.com/en/wines/whites/ventada>) – were probably not very different from people’s expectations for a rosé wine (Ballester et al., 2009). Therefore, one might have expected assimilation to have occurred, whereby the fake rosé was experienced as having similar aromas and flavours as what an actual rosé would give. As a result, the fake rosé would be attributed with the same proportion of red fruit descriptors as the real rosé.

While experienced participants perceived a high proportion of red fruit flavours in the fake rosé wine, it is worth pointing out that they were not the only ones liable to perceive characteristics that were not chemically present in the wine sample. Figure 2 reveals that beginners found red fruit descriptors (11% of all smell descriptors and 15% of all flavour descriptors) even in the white wine. This observation is in line with Parr et al.’s (2003) results, where novices demonstrated indiscriminate use of odour descriptors presumably due to the difficulty of the task. In fact, in the present study, beginners found it significantly more difficult to describe wine odour and flavour compared to experienced tasters.

One possibly caveat of the present study is that the participants could simply have chosen descriptors that matched the colour of the wines instead of the aroma/flavours. If this were to have been the case, however, we would have expected to see similar descriptor distributions between the aroma and flavour descriptors. Figure 2 shows that, for example, while the fake rosé wine had a predominance of floral aromas on the nose, floral descriptors were not dominant on the palate.

Another caveat was that we used a convenience sampling based on attendance at the wine symposium. The three expertise groups (beginner, intermediate, expert) were not age and gender matched, therefore we cannot rule out age or gender effects in the differences in results. Moreover, the three expertise groups were of quite different sizes (22, 62, and 79), with the beginner group being notably smaller than the intermediate and expert group. While it is possible that a larger beginner group might have exhibited the same colour-induced olfactory/flavour biases as the more expert groups, the results from the present study show a significant difference in the way in which beginners characterise both the rosé and dyed rosé wines, as compared to those with more wine expertise. Specifically, beginners do not associate red fruit descriptors even with the actual rosé wine, and tend to use the same type of descriptors for both the white wine

and rosé wine. It should also be said that the categorisation of participants in the present study was solely based on self-report. A test of wine knowledge, such as performed in D'Alessandro and Pecotich (2013), would presumably have improved the reliability of this categorisation.

Furthermore, due to the constraint of conducting the study globally with every participant at the same time, we could not fully randomise the order of the wines. Therefore, all participants received the fake rosé last, with only the order of the first two wines (the undyed white and rosé) randomised. It would have been interesting to have tested the extent to which the order of sampling influenced judgements of R'.

Based on the analyses of participants' quantitative wine ratings, description difficulty was negatively associated with both wine liking and flavour intensity (presumably it is more difficult to make out component descriptors in less intense wines). Interestingly, dyeing the wine pink did not appear to influence perceived flavour intensity, contrary to what might have been expected based on prior research (Clydesdale et al., 1993; Lavin & Lawless, 1998; though see also Reinoso-Carvalho et al., 2019). This was possibly because flavour intensity is influenced by colour intensity, and dyeing the wine a pale pink colour was not insufficient to influence the participants' colour intensity judgments. In addition, it was especially telling that the fake rosé wine was liked the least and judged to be the hardest to describe as compared to the two unadulterated wines. It is as if, somehow, participants picked up on the fact that there was something confusing about the fake rosé, which was reflected in the description difficulty ratings and liking ratings. One might think of this as a kind of metacognitive awareness of multisensory conflict (Deroy, Spence, & Noppenay, 2016). Had the participants been timed in their responses, we would predict that participants would have taken a longer time to come up with descriptors for the fake rosé. Nevertheless, it is telling that, even though participants did detect some differences between the real and fake rosé, they nevertheless ascribed red fruit characteristics to what was essentially a white wine.

5. Conclusions

The present study, with the largest sample size of its kind, demonstrates the role of wine colour in shaping both smell and flavour evaluations. The participants, especially those with some degree of wine tasting experience, used more similar vocabulary to describe

a white wine that had been dyed pink and an actual rosé wine, as compared to an unaltered white wine. This was shown in the distribution of free-choice descriptors – for both aroma and flavour – that our participants attributed to the wines. For the first time, we showed that mimicking the colour of a rosé wine can influence both the perceived aroma and flavour of a white wine.

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Conflicts of interest

The authors declare no conflicts of interest.

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Tables

Table 1. Technical information for the white wine (Raimat Ventada 2017) and rosé wine (Raimat Rosada 2007) used in the study.

	Alcohol by volume (%)	Residual sugar (g/L)	pH	Total Acidity (g/L)
Raimat Ventada 2017	12.75	1.5	3.1	5.5
Raimat Rosada 2017	12	4.5	3.2	5.9

Table 2. Spectrophotometry colour absorbance parameters for the three wine samples. W = white wine, R' = white wine dyed pink, R = rosé wine. Colour hue refers to the development of colour towards orange. Colour density and intensity refers to the amount of colour in the wine. Colour density only takes into account spectrums of yellow and red whereas colour intensity also includes the blue spectrum (more relevant for younger wines).

Wine	Colour density ($A_{420\text{ nm}} + A_{520\text{ nm}}$)	Colour hue/tint ($A_{420\text{ nm}} / A_{520\text{ nm}}$)	Colour intensity ($A_{420\text{ nm}} + A_{520\text{ nm}} + A_{620\text{ nm}}$)
W	0.09	6.75	0.09
R'	0.26	1.28	0.27
R	0.31	1.61	0.32

Table 3. List of wine descriptors given to the participants during the study (translated into English). For each row, the category name is given in parentheses and was not shown to the participants.

BLOSSOM, ROSE, VIOLET (FLORAL)
GREEN APPLE, RED APPLE, GOOSEBERRY, PEAR, GRAPE (WHITE FRUIT)
GRAPEFRUIT, LEMON, LIME (CITRUS)
PEACH, APRICOT, NECTARINE (STONE FRUIT)
BANANA, LYCHEE, MANGO, MELON, PASSION FRUIT, PINEAPPLE (TROPICAL FRUIT)
REDCURRANT, CRANBERRY, RASPBERRY, STRAWBERRY, RED CHERRY, PLUM (RED FRUIT)
BLACKCURRANT, BLACKBERRY, BLUEBERRY, BLACK CHERRY (BLACK FRUIT)

Table 4. Pearson's correlation coefficients between ratings of liking, flavour intensity, and description difficulty (N=503). * indicates significance at .05 level, and ** indicates significance at the .01 level.

	Liking	Intensity	Difficulty
Liking	1.0	0.41 **	-0.18 **
Intensity	-	1.0	-0.09 *
Difficulty	-	-	1.0

Table 5. Mean liking, flavour intensity, and description difficulty ratings (on 1-9 scales) for each wine tested in the present study. Standard error of the means shown in parentheses.

	White wine (W)	Rosé wine (R)	Fake rosé (R')
Liking	5.15 (.14)	5.15 (.15)	4.61 (.17)
Intensity	4.86 (.17)	5.26 (.17)	4.94 (.17)
Description difficulty	5.25 (.17)	5.17 (.17)	5.70 (.17)

Table 6. Distribution of the top five commonly selected aroma and flavour descriptors for the three wines, sorted by participant expertise level. Note that the right-most column shows the total participant population. As there were a possibility of 30 total descriptors, all shown descriptors were chosen at above-chance levels. Distribution % is normalised as the percentage of the total number of descriptors selected for a particular wine and by the particular set of participants.

White wine aroma											
Beginner			Intermediate			Expert			All		
Descriptor	Coun t	%	Descriptor	Coun t	%	Descriptor	Coun t	%	Descriptor	Coun t	%
green apple	8	13%	green apple	28	15%	green apple	31	13%	green apple	67	14%
lychee	7	11%	floral	18	10%	floral	26	11%	floral	51	10%
pineapple	5	8%	pineapple	15	8%	pear	24	10%	pear	42	9%
grape	4	6%	grapefruit	15	8%	lemon	24	10%	lemon	41	8%
banana	4	6%	banana	14	8%	pineapple	20	9%	pineapple	40	8%
Rosé wine aroma											
Beginner			Intermediate			Expert			All		
Descriptor	Coun t	%	Descriptor	Coun t	%	Descriptor	Coun t	%	Descriptor	Coun t	%
floral	8	13%	strawberry	20	11%	strawberry	35	15%	strawberry	58	12%
green apple	7	11%	rose	20	11%	floral	23	10%	rose	49	10%
grapefruit	6	10%	raspberry	19	10%	rose	22	10%	floral	44	9%
rose	5	8%	redcurrant	14	8%	raspberry	19	8%	raspberry	39	8%
grape	5	8%	floral	11	6%	redcurrant	15	7%	grapefruit	31	6%

Fake rosé wine aroma

Beginner			Intermediate			Expert			All		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
rose	7	11%	strawberry	19	11%	floral	33	15%	floral	59	13%
floral	6	10%	floral	18	10%	strawberry	21	10%	strawberry	47	10%
banana	5	8%	rose	18	10%	rose	19	9%	rose	45	10%
pineapple	5	8%	violet	12	7%	violet	15	7%	violet	32	7%
strawberry	5	8%	banana	10	6%	peach	12	5%	pear	21	4%

White wine flavour

Beginner			Intermediate			Expert			All		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
green apple	11	18%	green apple	23	13%	green apple	40	18%	green apple	78	17%
grapefruit	8	13%	lemon	20	11%	lemon	33	15%	lemon	56	12%
grape	5	8%	pineapple	20	11%	grapefruit	25	11%	grapefruit	54	11%
lychee	4	6%	grapefruit	18	10%	pineapple	23	10%	pineapple	45	10%
floral	4	6%	lime	16	9%	lime	19	9%	lime	38	8%

Rosé wine flavour

Beginner			Intermediate			Expert			All		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
green apple	7	11%	strawberry	19	11%	strawberry	33	15%	strawberry	56	12%
grape	5	8%	redcurrant	16	9%	grapefruit	30	14%	grapefruit	50	11%
lemon	5	8%	grapefruit	15	9%	raspberry	20	9%	raspberry	35	7%
pear	4	7%	raspberry	13	8%	lemon	17	8%	redcurrant	32	7%

peach	4	7%	red cherry	11	6%	green apple	12	5%	lemon	31	7%
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Fake rosé wine flavour

Beginner			Intermediate			Expert			All		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
green apple	7	11%	grapefruit	17	11%	grapefruit	26	12%	grapefruit	52	12%
grapefruit	6	10%	strawberry	16	10%	strawberry	21	10%	strawberry	42	9%
rose	4	7%	lemon	14	9%	lemon	15	7%	lemon	34	8%
lemon	4	7%	lime	11	7%	red cherry	14	7%	red cherry	24	5%
lychee	4	7%	red apple	10	6%	nectarine	13	6%	lime	24	5%

645

646

647 **Table 7.** Cosine similarity measurements (0 = totally dissimilar, 1 = totally similar) as
648 well as chi-squared tests of independence for different pairs of wines in the present
649 study. Chi-squared tests are based on chosen descriptor frequencies. W = white wine,
650 R = rosé wine, R' = fake rosé wine. * indicates $p < .05$ level, ** indicates $p < .01$ level.

Overall - Smell			Overall – Flavour		
Wine pair	Cosine similarity	χ^2	Wine pair	Cosine similarity	χ^2
R W	0.56	62.14 **	R W	0.69	40.03 **
R R'	0.93	4.29	R R'	0.96	2.96
W R'	0.62	43.87 **	W R'	0.75	32.92 **
Beginner - Smell			Beginner - Flavour		
Wine pair	Cosine similarity	χ^2	Wine pair	Cosine similarity	χ^2
R W	0.64	38.58 **	R W	0.76	10.40
R R'	0.59	33.81 **	R R'	0.83	13.40 *
W R'	0.61	19.35 **	W R'	0.82	7.32
Intermediate - Smell			Intermediate - Flavour		
Wine pair	Cosine similarity	χ^2	Wine pair	Cosine similarity	χ^2
R W	0.43	61.81 **	R W	0.59	50.30 **
R R'	0.89	36.99 **	R R'	0.88	5.70
W R'	0.57	26.57 **	W R'	0.70	41.75 **
Expert - Smell			Expert - Flavour		
Wine pair	Cosine similarity	χ^2	Wine pair	Cosine similarity	χ^2
R W	0.48	55.07 **	R W	0.62	50.09 **
R R'	0.89	9.34	R R'	0.95	4.53
W R'	0.59	55.43 **	W R'	0.71	38.71 **

651

Appendix A

Distribution of all aroma descriptors for the three wines, sorted by participant expertise level. Distribution % is normalised as the percentage of the total number of descriptors selected for a particular wine and by the particular set of participants.

Beginner

White wine aroma			Rosé aroma			Fake rosé aroma		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
manzana-verde	8	13%	floral	8	13%	rosa	7	11%
lichi	7	11%	manzana-verde	7	11%	floral	6	10%
pina	5	8%	pomelo	6	10%	platano	5	8%
uva	4	6%	rosa	5	8%	pina	5	8%
platano	4	6%	uva	5	8%	fresa	5	8%
floral	4	6%	pera	4	7%	ciruela	4	7%
lima	3	5%	melon	3	5%	violeta	3	5%
pera	3	5%	zarzamora	3	5%	cereza-roja	3	5%
melon	3	5%	melocoton	3	5%	melon	3	5%
fresa	3	5%	albaricoque	3	5%	manzana-roja	3	5%
limon	3	5%	violeta	2	3%	limon	3	5%
albaricoque	2	3%	mango	2	3%	albaricoque	2	3%
frambuesa	2	3%	grosella-espinosa	1	2%	pera	2	3%
violeta	2	3%	fresa	1	2%	grosella-espinosa	1	2%
nectarina	2	3%	cereza-roja	1	2%	mango	1	2%
mango	1	2%	manzana-roja	1	2%	zarzamora	1	2%

pomelo	1	2%	frambuesa	1	2%	lichi	1	2%
melocoton	1	2%	nectarina	1	2%	melocoton	1	2%
rosa	1	2%	limon	1	2%	pomelo	1	2%
manzana-roja	1	2%	fruta-de-la-pasion	1	2%	nectarina	1	2%
cereza-roja	1	2%	cereza-negra	1	2%	arandano-azul	1	2%
grosella-roja	1	2%	grosella-roja	1	2%	manzana-verde	1	2%
						fruta-de-la-pasion	1	2%

Intermediate

White wine aroma			Rosé aroma			Fake rosé aroma		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
manzana-verde	28	15%	fresa	20	11%	fresa	19	11%
floral	18	10%	rosa	20	11%	floral	18	10%
pina	15	8%	frambuesa	19	10%	rosa	18	10%
pomelo	15	8%	grosella-roja	14	8%	violeta	12	7%
platano	14	8%	floral	11	6%	platano	10	6%
pera	14	8%	violeta	11	6%	frambuesa	9	5%
limon	13	7%	pomelo	10	5%	manzana-roja	7	4%
lichi	13	7%	cereza-roja	10	5%	pomelo	7	4%
lima	11	6%	melocoton	9	5%	pera	7	4%
melon	8	4%	manzana-roja	6	3%	melocoton	6	3%
violeta	7	4%	pera	5	3%	pina	5	3%

albaricoque	5	3%	platano	5	3%	cereza-roja	5	3%
mango	5	3%	ciruela	5	3%	melon	5	3%
melocoton	4	2%	lichi	5	3%	fruta-de-la-pasion	5	3%
fruta-de-la-pasion	4	2%	manzana-verde	4	2%	nectarina	5	3%
nectarina	3	2%	arandano-rojo	4	2%	lichi	4	2%
uva	3	2%	melon	3	2%	arandano-rojo	4	2%
manzana-roja	2	1%	limon	3	2%	uva	4	2%
fresa	1	1%	pina	3	2%	zarzamora	3	2%
rosa	1	1%	fruta-de-la-pasion	3	2%	manzana-verde	3	2%
frambuesa	1	1%	cereza-negra	3	2%	lima	3	2%
			mango	2	1%	albaricoque	3	2%
			nectarina	2	1%	grosella-negra	2	1%
			lima	2	1%	ciruela	2	1%
			albaricoque	1	1%	cereza-negra	2	1%
			grosella-negra	1	1%	limon	2	1%
			uva	1	1%	grosella-roja	2	1%
						mango	1	1%
						grosella-espinosa	1	1%

Expert

White wine aroma			Rosé aroma			Fake rosé aroma		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%

manzana-verde	31	13%	fresa	35	15%	floral	33	15%
floral	26	11%	floral	23	10%	fresa	21	10%
pera	24	10%	rosa	22	10%	rosa	19	9%
limon	24	10%	frambuesa	19	8%	violeta	15	7%
pina	20	9%	grosella-roja	15	7%	melocoton	12	5%
pomelo	16	7%	pomelo	14	6%	cereza-roja	12	5%
platano	15	6%	cereza-roja	11	5%	pera	10	5%
lima	13	6%	violeta	9	4%	grosella-roja	9	4%
lichi	11	5%	manzana-roja	7	3%	manzana-roja	8	4%
melon	9	4%	lichi	7	3%	frambuesa	7	3%
melocoton	8	3%	lima	7	3%	melon	7	3%
rosa	6	3%	platano	6	3%	platano	6	3%
fruta-de-la-pasion	5	2%	fruta-de-la-pasion	6	3%	nectarina	6	3%
uva	5	2%	melocoton	6	3%	manzana-verde	5	2%
nectarina	4	2%	limon	6	3%	lima	5	2%
manzana-roja	4	2%	nectarina	4	2%	lichi	5	2%
albaricoque	4	2%	manzana-verde	4	2%	albaricoque	5	2%
mango	3	1%	pera	4	2%	zarzamora	5	2%
violeta	2	1%	uva	4	2%	pomelo	5	2%
grosella-roja	1	0%	pina	3	1%	limon	5	2%
fresa	1	0%	mango	3	1%	uva	4	2%
			ciruela	3	1%	arandano-rojo	4	2%

melon	3	1%	ciruela	3	1%
arandano-rojo	3	1%	mango	2	1%
albaricoque	2	1%	grosella-negra	1	0%
zarzamora	2	1%	arandano-azul	1	0%
grosella-negra	1	0%	fruta-de-la-pasion	1	0%
grosella-espinosa	1	0%	pina	1	0%
			grosella-espinosa	1	0%
			cereza-negra	1	0%

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Appendix B

Distribution of all flavour descriptors for the three wines, sorted by participant expertise level. Distribution % is normalised as the percentage of the total number of descriptors selected for a particular wine and by the particular set of participants.

Beginner								
White wine flavour			Rosé flavour			Fake rosé flavour		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
manzana-verde	11	18%	manzana-verde	7	11%	manzana-verde	7	11%
pomelo	8	13%	uva	5	8%	pomelo	6	10%
uva	5	8%	limon	5	8%	rosa	4	7%
lichi	4	6%	pera	4	7%	limon	4	7%
floral	4	6%	melocoton	4	7%	lichi	4	7%
lima	3	5%	arandano-azul	3	5%	fresa	4	7%
pera	3	5%	pomelo	3	5%	violeta	3	5%
ciruela	2	3%	grosella-roja	3	5%	floral	3	5%
cereza-roja	2	3%	cereza-roja	2	3%	arandano-azul	3	5%
melon	2	3%	arandano-rojo	2	3%	uva	3	5%
nectarina	2	3%	nectarina	2	3%	grosella-roja	2	3%
grosella-roja	2	3%	rosa	2	3%	lima	2	3%
pina	2	3%	cereza-negra	2	3%	mango	2	3%

manzana-roja	2	3%	fruta-de-la-pasion	2	3%	melocoton	2	3%
limon	1	2%	albaricoque	2	3%	arandano-rojo	2	3%
frambuesa	1	2%	mango	2	3%	cereza-roja	2	3%
fresa	1	2%	fresa	2	3%	frambuesa	1	2%
fruta-de-la-pasion	1	2%	pina	2	3%	albaricoque	1	2%
platano	1	2%	grosella-espinosa	1	2%	pera	1	2%
cereza-negra	1	2%	manzana-roja	1	2%	cereza-negra	1	2%
albaricoque	1	2%	melon	1	2%	fruta-de-la-pasion	1	2%
arandano-rojo	1	2%	zarzamora	1	2%	pina	1	2%
melocoton	1	2%	floral	1	2%	manzana-roja	1	2%
mango	1	2%	lima	1	2%	nectarina	1	2%
			violeta	1	2%			

Intermediate

White wine flavour			Rosé flavour			Fake rosé flavour		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
manzana-verde	23	13%	fresa	19	11%	pomelo	17	11%
limon	20	11%	grosella-roja	16	9%	fresa	16	10%
pina	20	11%	pomelo	15	9%	limon	14	9%

pomelo	18	10%	frambuesa	13	8%	lima	11	7%
lima	16	9%	cereza-roja	11	6%	manzana-roja	10	6%
floral	10	6%	lima	9	5%	frambuesa	9	6%
lichi	9	5%	limon	9	5%	rosa	8	5%
pera	8	5%	manzana-verde	8	5%	cereza-roja	8	5%
platano	8	5%	melocoton	7	4%	nectarina	8	5%
melon	7	4%	arandano-rojo	6	3%	pina	7	4%
nectarina	5	3%	pera	6	3%	zarzamora	5	3%
melocoton	5	3%	ciruela	5	3%	ciruela	5	3%
manzana-roja	4	2%	manzana-roja	5	3%	melocoton	5	3%
fruta-de-la-pasion	4	2%	fruta-de-la-pasion	5	3%	uva	5	3%
albaricoque	3	2%	rosa	4	2%	melon	4	2%
uva	3	2%	nectarina	4	2%	manzana-verde	4	2%
mango	3	2%	pina	4	2%	grosella-roja	4	2%
fresa	2	1%	lichi	4	2%	arandano-rojo	4	2%
arandano-rojo	1	1%	uva	4	2%	pera	3	2%
arandano-azul	1	1%	violeta	3	2%	albaricoque	3	2%
grosella-espinosa	1	1%	floral	3	2%	cereza-negra	3	2%
ciruela	1	1%	melon	3	2%	floral	2	1%

rosa	1	1%	albaricoque	3	2%	arandano-azul	2	1%
violeta	1	1%	cereza-negra	2	1%	grosella-espinosa	1	1%
			platano	2	1%	lichi	1	1%
			grosella-negra	1	1%	violeta	1	1%
			arandano-azul	1	1%	fruta-de-la-pasion	1	1%

Expert

White wine flavour			Rosé flavour			Fake rosé flavour		
Descriptor	Count	%	Descriptor	Count	%	Descriptor	Count	%
manzana-verde	40	18%	fresa	33	15%	pomelo	26	12%
limon	33	15%	pomelo	30	14%	fresa	21	10%
pomelo	25	11%	frambuesa	20	9%	limon	15	7%
pina	23	10%	limon	17	8%	cereza-roja	14	7%
lima	19	9%	manzana-verde	12	5%	nectarina	13	6%
pera	13	6%	lima	12	5%	manzana-verde	11	5%
melocoton	9	4%	grosella-roja	12	5%	lima	11	5%
nectarina	8	4%	pina	11	5%	frambuesa	10	5%
uva	8	4%	cereza-roja	11	5%	pina	9	4%
platano	6	3%	nectarina	10	5%	pera	7	3%

melon	6	3%	manzana-roja	7	3%	floral	7	3%
lichi	5	2%	arandano-rojo	6	3%	rosa	7	3%
floral	5	2%	melon	5	2%	manzana-roja	7	3%
fruta-de-la-pasion	4	2%	rosa	5	2%	melocoton	6	3%
albaricoque	4	2%	albaricoque	5	2%	grosella-roja	6	3%
manzana-roja	4	2%	fruta-de-la-pasion	4	2%	arandano-rojo	6	3%
rosa	2	1%	melocoton	4	2%	ciruela	5	2%
grosella-espinosa	2	1%	floral	3	1%	albaricoque	5	2%
mango	2	1%	platano	3	1%	platano	4	2%
ciruela	1	0%	lichi	3	1%	uva	3	1%
fresa	1	0%	ciruela	3	1%	mango	3	1%
grosella-roja	1	0%	pera	1	0%	melon	3	1%
			violeta	1	0%	cereza-negra	3	1%
			zarzamora	1	0%	fruta-de-la-pasion	2	1%
			grosella-negra	1	0%	violeta	2	1%
			mango	1	0%	grosella-espinosa	2	1%
			uva	1	0%	lichi	2	1%
						arandano-azul	2	1%

	grosella- negra	1	0%
	zarzamora	1	0%

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