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From perceptual to conceptual categorization of wines: What is the effect of expertise?

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Highlights:

- Perceptual categorization is driven by sensory characteristics whatever the expertise level
- Conceptual categorization is driven by wine knowledge and experience
- Blind tasting could have activated a script in expert memory instead of a prototype
- There is an effect of expertise in the vocabulary used to describe the wine groups

Abstract

Wine supply in the French market is structured in an intricate system of categories based on origin. There is very little knowledge about consumers understanding of this complex category system and the sensory styles behind these categories. This study investigated how assessors with different level of expertise categorized Beaujolais wines from general to more specific levels of categorization (grape variety, appellation, and "*lieu-dit*") in both perceptual (wines) and conceptual (wine labels) conditions. Based on the literature on expertise, we expected a stronger effect in the perceptual condition, in particular for the most specific levels of categorization. For each wine categorization level, three sets of 12 wines were tasted by three panels of 60 assessors: a panel of unfamiliar novices with no much exposure to Beaujolais wines; a panel of familiar novices with regular exposure to Beaujolais wines; and a panel of experts from the Beaujolais. In both perceptual and conceptual conditions, assessors were asked to perform a binary sorting task, followed by a verbalisation task. Data were analysed using DISTATIS. At each level, with a few exceptions, a clearer separation was observed between the two categories in the conceptual condition than in the perceptual condition. Although the experts categorized the labels by grape variety, they did not spontaneously categorize the wines in that way. Finally, we observed a clear expertise effect only in the conceptual condition. This result will be discussed in terms of expertise acquisition and categorization processes.

Keywords: expertise; familiarity; blind tasting; categorization; binary sorting; wine

1. Introduction

Like many PDO food products, wine is a very diversified and complex product. To facilitate consumers' understanding of this diversity, wine books or guides propose some classification systems based on colour, vineyard (i.e. a wine-producing region) and/or grape variety. These classifications, however, vary between countries or within a country according to law regulations. For instance, in European countries like France, Italy, Spain, and Portugal, the classification progressively extends across Protected Designation of Origin (PDO) level. In France, the hierarchy of appellation globally starts with regional appellations, and goes till communal appellations, with occasionally *premier cru* or *grand cru* designations. In addition, the wines produced in the different vineyards within each country are very diversified and complex because of specific regulations within a same vineyard, as is the case in France. This complexity is reinforced by the high diversity of wine labels. Wine labels are diversified in terms of colours, level of information, pictures and styles within a same wine category. The type of information provided on the label also depends on the country regulation policies: certain information, like the name of the grape variety or the vineyard, is not mandatory whereas others are. As a consequence, it is rather complicated for consumers to identify information in relation to wine classifications.

The perception of the hierarchical and complex wine organization had been investigated in a previous study by Honoré-Chedozeau, Lelièvre-Desmas, Ballester, Chollet, & Valentin (2017). Three panels of different levels of expertise: wine professionals, familiar consumers and unfamiliar consumers with Beaujolais wines performed a free hierarchical sorting task (FHS) of wine labels of different vineyard, grape varieties and Beaujolais PDO wines. The FHS results showed that the three panels formed common groups that followed the wine taxonomy system indicating a common conceptual knowledge of this system. Interviews conducted after the sorting task, however, revealed that the panels had not used the same strategies for categorizing the wine labels: most of the experts and the familiar consumers used top-down strategies based on their knowledge while the unfamiliar consumers used bottom-up strategies based on the search of clues to compensate their lack of knowledge/exposure to wines. This study, conducted with wine labels, raises the question of whether such a difference in categorization strategy would occur during blind tasting.

A number of studies addressed this question. For instance, Ballester, Abdi, Langlois, Peyron, & Valentin (2009) asked expert and novice assessors to smell a set of red, white and rosé wines presented in dark glasses and to sort them into colour categories. A clear separation was observed between the white and the red wines for both groups indicating that experts and novices have developed a clear representation of the odour of red and white wines. In contrast, Ballester, Patris, Symoneaux, & Valentin (2008) and Solomon (1997) showed that whereas wine experts clearly sorted white wines by grape variety, novices tended to sort them according to surface-based criteria such as sweetness or fruitiness. The ability of experts to categorize wines according to grape variety was also demonstrated by Llobodanin, Barroso, & Castro (2014): Sommeliers were able to recognize the correct grape varieties among certain South American red wines (particularly for Malbec, Cabernet Sauvignon and Carménère wines). Finer categorizations can also be observed for experts. For example, Parr, Green,

White, & Sherlock (2007) report that wine experts from New Zealand were able to classify Sauvignon blanc wines by area of production. For a same vineyard (Touraine area from the Loire Valley), Pagès (2005) showed that wine experts could separate white wines from two different origins and different grape varieties (Chenin wines from Vouvray PDO vs Sauvignon blanc wines from Touraine PDO). However, experts are not always able to classify wines according to PDO when the wines are made from a single grape variety. For instance, Jaffré (2009) showed that wine professionals did not distinguished the Fleurie PDO wines from other Beaujolais PDO wines.

Most of the authors of the previously cited studies build on psychological models of categorization to explain their results. Following Rosch & Mervis (1975)'s work they assume that the expert superiority in wine categorization can be explained in terms of prototype abstraction. Through repeated exposures to wines from different categories, experts would develop some kind of prototypes or central tendency that represents the sensory "signature" of these categories (Parr, Valentin, Green, & Dacremont, 2010). As Parr *et al.* (2007, p. 851) put it when talking about Sauvignon blanc wines: "*those experienced with Marlborough Sauvignon blanc will have developed internalised standards (i.e., a concept) about the wine that will have a central tendency (an ideal or typical example) and boundaries (i.e., limits in terms of variation from the ideal example that can be tolerated before a wine is deemed outside the concept)*". Further categorization would then be made with reference to these prototypes. This interpretation supposes that experts have a holistic perception of wines by unconsciously activating prototypes when asked to categorize a set of wines. Yet, according to Rabin (1988), during training experts are taught to focus on wine distinctive features and thus taste wines analytically. Further work is thus needed to understand how wine tasters apprehend wine, to what extent experts develop a clear representation of the wine complex hierarchical classification system and, whether this representation differs from that of familiar (*i.e.* previously exposed to) and unfamiliar consumers, both at a perceptual and at a conceptual level.

To address this question, we compared Beaujolais red wine categorization by wine professionals and consumers. The Beaujolais region mainly produced red wines, made from the single Gamay grape variety. This vineyard includes 12 PDOs red wines that are organized and regulated by law, according to two regional appellations (Beaujolais PDO and Beaujolais-Villages PDO) and 10 communal appellations, referred to as *crus*, (Régnié, Fleurie, Morgon, Moulin-à-Vent, Brouilly, Côte-de-Brouilly, Juliéna, Saint-Amour, Chénas, and Chiroubles PDOs). Some *crus* are further divided into *lieux-dits* (a French term for wines which are made exclusively from a small historical plot with a locality name). For instance, among the Morgon PDO wines, we can find "Morgon Côtes-du-Py" or "Morgon Grand Cras".

We asked three groups of participants with different levels of expertise/familiarity in Beaujolais wines to perform binary sorting tasks at three levels of categorization: 1) grape variety level, which is the most general level, 2) appellation level, which is an intermediate level, and 3) "*lieu-dit*" level, which is the most specific one. The first group of participants were wine professionals from the Beaujolais area, which we call experts. The second group were consumers from the Beaujolais area which we call familiar novices, and the third group

were consumers from a very distant region of Beaujolais area and non-wine producing (the North of France) which we called unfamiliar novices.

To evaluate if the effect of expertise affects differently wine tasters' perceptual and conceptual representations, we used two experimental conditions. In the first condition, experts and novices blind tasted the wines and were asked to sort the wines in two groups, without any information (perceptual condition). In the second condition, they had to perform the same sorting task but with the labels of the wines they previously tasted in the first condition, without any tasting (conceptual condition). For the perceptual condition (blind tasting), we expected that the experts would rely more on top-down processes based on their experience and knowledge (*e.g.*, concepts or prototypes) about the wines to make the categorizations, than on bottom-up processes based on their sensory perception of the wines. In contrast, based on previous work we expected that novices would rely more on bottom-up processes (*e.g.*, sensory characteristics) than top-down processes to perform the task, especially unfamiliar novices. We focused our research on chemosensory aspects of the samples, therefore we used dark glasses in order to avoid results either biased or dominated by the visual cues (Morrot, Brochet, & Dubourdieu, 2001). For the conceptual condition (labels), we expected a lesser effect of expertise than for the perceptual condition as novices (especially familiar novices) might have derive some kinds of representation of the Beaujolais wine classification system *via* wine books, guides or restaurant menus (Honoré-Chedozeau et al., 2017).

2. Material and methods

2.1. Wines

We studied three levels of categories: (1) grape variety, (2) appellation, and (3) *lieu-dit* levels. For each level, we respectively selected two categories of wines (1) Gamay from Beaujolais vineyard (G) *vs.* Pinot Noir from Burgundy vineyard (P), (2) Morgon PDO (M) *vs.* Régnié PDO (R), and (3) "*lieu-dit*" (L) *vs.* not "*lieu-dit*" (NL) within the Morgon PDO. In order to generalize the results of this study, three sets of wines were selected to represent each of the three category levels.

For each level, twelve wines were randomly selected to constitute each set, six per wine category. This wine selection was realized from the different lists given by the interprofessions (Inter Beaujolais and Bureau Interprofessionnel des Vins de Bourgogne) for each category level. Each bottle has been checked by a sniffing after the bottles have been opened before the wine tastings to avoid off-flavours. The selected wines were all from the 2011 vintage for the grape variety level and all from the 2013 vintage for the appellation and the "*lieu-dit*" levels. Table 1 provides a list of the selected wines for the grape variety, the appellation and the *lieu-dit* levels.

Table 1: Overview of the selected wines for each set of the grape variety, the appellation and the *lieu-dit* levels.

Category level	Wine category	Wine PDO (code)		
		Set 1	Set 2	Set 3
Grape variety	Gamay	Juliéna (G1)	Fleurie (G7)	Fleurie (G13)
		Morgon (G2)	Moulin-A-Vent (G8)	Beaujolais-Villages (G14)
		Fleurie (G3)	Côte-De-Brouilly (G9)	Régnié (G15)
		Fleurie (G4)	Moulin-A-Vent (G10)	Régnié (G16)
		Moulin-à-Vent (G5)	Moulin-A-Vent (G11)	Fleurie (G17)
		Juliéna (G6)	Beaujolais (G12)	Beaujolais-Villages (G18)
	Pinot Noir	Nuits-Saint-Georges (P1)	Santenay (P7)	Bourgogne Côtes-d'Auxerre (P13)
		Marsannay (P2)	Vosne-Romanée (P8)	Chorey-Lès-Beaune (P14)
		Monthélie (P3)	Irancy (P9)	Pernand-Vergelesses (P15)
		Saint-Romain (P4)	Marsannay (P10)	Bourgogne Hautes Côtes-de-Beaune (P16)
		Gevrey-Chambertin (P5)	Gevrey-Chambertin (P11)	Bourgogne Côte Chalonnaise (P17)
		Volnay (P6)	Bourgogne Côtes-d'Auxerre (P12)	Marsannay (P18)
	Appellation	Morgon (from M1 to M6)	Morgon (from M7 to M12)	Morgon (from M13 to M18)
		Régnié (from R1 to R6)	Régnié (from R7 to R12)	Régnié (from R13 to R18)
<i>Lieu-dit</i>	<i>Lieu-dit</i>	Morgon <i>Corcelette</i> (L1)	Morgon <i>Côtes-du-Py</i> (L7)	Morgon <i>Charmes</i> (L13)
		Morgon <i>Côtes-du-Py</i> (L2)	Morgon <i>Grands Cras</i> (L8)	Morgon <i>Côtes-du-Py</i> (L14)
		Morgon <i>Charmes</i> (L3)	Morgon <i>Côtes-du-Py</i> (L9)	Morgon <i>Côtes-du-Py</i> (L15)
		Morgon <i>Côtes-du-Py</i> (L4)	Morgon <i>Douby</i> (L10)	Morgon <i>Côtes-du-Py</i> (L16)
		Morgon <i>Charmes</i> (L5)	Morgon <i>Côtes-du-Py</i> (L11)	Morgon <i>Grands Cras</i> (L17)
		Morgon <i>Corcelette</i> (L6)	Morgon <i>Côtes-du-Py</i> (L12)	Morgon <i>Grands Cras</i> (L18)
	Not <i>Lieu-dit</i>	Morgon (from NL1 to NL6)	Morgon (from NL7 to NL12)	Morgon (from NL13 to NL18)

2.2. Panels

For each wine set, we recruited three panels of assessors: (1) an expert panel including wine professionals from the Beaujolais vineyard including winemakers, vine and wine consultants, vine and wine engineers, laboratory technicians located around Villefranche-sur-Saône (experts), (2) a familiar novice panel including wine consumers who lived around the Beaujolais vineyard (familiar novices that are used to drink Beaujolais wines), and (3) an unfamiliar novice panel including wine consumers from Lille, an area without vineyards (unfamiliar novices). The panel characteristics are shown in Table 2. For both novice panels, red wines are the most frequently consumed. More precisely, the familiar novices drink more frequently wines from Beaujolais, Burgundy and the Northern Rhône while the unfamiliar novices drink more frequently wines from Bordeaux and Champagne (Table 3). For the perceptual condition, the two panels of novices (familiar and unfamiliar) were recruited by means of an online questionnaire in order to verify that they consumed wines but were not oenophiles. The online questionnaire included socio-demographic questions (gender, year of birth, town, and length of residence, socio-professional group and types of wines consumed) as well as wine tasting and consumption habits. The criteria used to select wine consumers were: not under the age of 18, consume wine at least annually, no professional wine

experience, no registration at a tasting club and no formal training in wine tasting or wine production. The conceptual condition task took place six months later with the same assessors, in order to minimize the memory bias of the perceptual task. This important time period between the two sessions had unfortunately generated unavailability among assessors for the second condition, which explains why the number is lower for the conceptual condition.

Table 2: Panel characteristics.

Panel		Experts		Familiar novices		Unfamiliar novices	
Condition		Perceptual	Conceptual	Perceptual	Conceptual	Perceptual	Conceptual
Set 1	Number	19 (15/4)	13	20 (9/11)	12	20 (6/14)	18
	(Men/Women)						
Set 2	Mean age	49		44		51	
	Number	20 (17/3)	14	20 (11/9)	10	20 (9/11)	18
Set 3	(Men/Women)						
	Mean age	45		46		45	
Set 3	Number	19 (12/7)	12	20 (13/7)	16	20 (8/12)	20
	(Men/Women)						
	Mean age	51		43		46	

Table 3: Wine drinking habits of the novice panels for each set.

Type of novice panel		Familiar novices			Unfamiliar novices		
Type of set		Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Frequency of wine consumption							
One to ten times a year		0	1	0	0	2	2
One to ten times a month		5	6	4	5	5	4
Once or twice a week		5	5	9	8	7	4
Every week-end		7	2	6	4	1	7
Every day		3	6	1	3	5	3
Types of wines consumed (%)							
White wine		40	35	45	65	60	60
Rosé wine		20	30	30	60	55	65
Red wine		85	80	80	75	65	90
Sparkling wine		10	5	0	50	40	40
Origin of wines most frequently consumed (%)							
Alsace		5	10	10	20	15	20
Beaujolais		80	80	65	15	30	15
Bordeaux		20	15	35	55	50	75
Burgundy		55	60	45	20	15	10
Champagne		5	5	10	50	40	35
Charentes		0	0	0	5	10	5
Corsica		0	5	0	0	0	0
Jura/Savoy		5	0	0	15	35	10
Languedoc-Roussillon		10	10	15	10	10	25
Provence		15	15	0	30	40	30
South-West France		0	0	5	15	5	15
Loire Valley		5	5	15	25	25	15
Northern Rhone		75	75	50	5	5	25

2.3. Experimental design

For each panel, assessors participated to four sessions: a perceptual condition (wine categorization) carried out into three sessions (one per level), and a conceptual condition (wine label categorization), carried out into a single session six months after the third session. The whole procedure is schematized in Fig 1 to facilitate understanding.

2.3.1. Procedure

For each set of wines and each condition, assessors were asked to perform a binary sorting task coupled to a verbalization. For each assessor within a panel, the three category levels were randomly distributed into the three sessions for the perceptual condition. For the conceptual condition, a same assessor received the three category levels in the same order than those of the perceptual condition. No information was given about the wines, or the purpose of the study. There was no time limit to perform each sorting. Each session lasted about 30 minutes. Water was available during each session.

2.3.2. Perceptual condition sessions

For the perceptual condition, the twelve wines were presented simultaneously, in a random order following Latin squares. Twenty-mL wine samples were served at ambient temperature in black ISO glasses, identified by a random 3-digit code, and covered with plastic Petri dishes. For each session, assessors were asked to taste the wines and to sort them in two groups according to the following instruction: *“Please group the wines into two groups, by putting together the wines that are similar”*. After the sorting task, assessors were asked to briefly describe with their own words and expressions the two groups they formed.

2.3.3. Conceptual condition session

For the conceptual condition, the labels of each bottle of the three category levels were removed (front label, back label, award, and particular vintage label), scanned, and printed as colour cards (14.8 x 21 cm) for each set. Each card was then identified by a random 3-digit code on the reverse side, different from that of the corresponding wines in the perceptual condition. The assessors had to make three successive binary sorting tasks, one for each category level, by sorting the labels into two groups according to the following instruction: *“Please look at the wine labels and group the wines that, in your opinion, belong to the same wine category into two groups”*. After each binary sorting, assessors were asked to briefly describe with their own words and expressions the two groups they formed.

2.4. Data analysis

2.4.1. Binary sorting data analysis

For each panel, each set, each level and each condition, data from the binary sorting were encoded in a rectangular matrix where the rows represent the wines (or the labels) and the columns represent the corresponding group numbers of wines (*i.e.* “1” for each wine (or label) placed in the first group, and “2” for each wine (or label) placed in the second group). The matrices were analysed separately using DISTATIS, and then compared. DISTATIS is a

statistical method which is a generalisation of classical multidimensional scaling (Abdi & Valentin, 2007). This method permits to take into account individual sorting data and provides graphical representation of wines and assessors (for a tutorial about the method, see Abdi, Valentin, Chollet, & Chrea, 2007).

The coordinates of the wines (or labels) for all the dimensions on the DISTATIS maps are then used as input to a Hierarchical Ascending Classification (HAC), in order to identify the two groups formed by each panel. These statistical analyses were performed using the free software R, version 3.2.3 for Windows (R Core Team, 2015) with the additional R packages *DistatisR* (Beaton, Fatt, & Abdi, 2013) and *FactoMineR* (Lê, Josse, & Husson, 2008).

To evaluate the match between the groups made by the assessors and the *a priori* categories from the Beaujolais wine classification, we computed a score for each assessor. This score varied from zero (the two groups are made of an equivalent number of wines of each *a priori* category) to six (*i.e.* a perfect sorting of the wines into the two *a priori* categories). This score was calculated as the absolute value of the number of wines from the first category (x_1) minus the number of wines from the second category (y_1) in the first group ($|x_1 - y_1|$) plus the absolute value of the number of wines from the first category (x_2) minus the number of wines from the second category (y_2) in the second group ($|x_2 - y_2|$) divided by 2 ($(|x_1 - y_1| + |x_2 - y_2|)/2$). For example, if an assessor formed a first group of three Pinot Noir and one Gamay, and a second group of three Pinot Noir and five Gamay, the score will then be equal to $(|3 - 1| + |3 - 5|)/2 = 2$. Then, we calculated an average score for each panel, each level, each set and each condition in order to quantify the tendency of the assessors to separate the wines (or the labels) into the two *a priori* categories within each panel, at both the panel and the individual levels. A mixed design three-way analysis of variance (ANOVA) was carried out considering the panel as between-subject fixed factor and the condition and level of categorization as within-subject fixed factors. Individual scores were used as dependent variable. As the design was unbalanced, we used Type III Sum of squares. Duncan multiple comparison tests were performed with $\alpha = 5\%$ when a significant effect of panel and level was found. These analyses were performed under XLSTAT Premium (version 19.5).

2.4.2. Verbalization data analysis

All the terms and expressions used by the assessors to describe the groups of wines (or labels) for each level of categorization and each set were first compiled in a list for each condition. A semi-automatic procedure was used to lemmatize and to categorize the words in the lists by using the SPAD software (version 8.2, CISIA-CESRESTA, Montreuil, France). For each condition, terms were then encoded in a rectangular matrix where the rows represent the terms and the columns represent the three levels of categorisation for each of the three panels. Data were finally analysed by Correspondence Analysis (CA) for each condition, using the SPAD software, in order to determine and to compare the type of verbalization used by each panel for the description of the two groups of wines (or labels) whatever the level. Only the terms that best characterized each type of panel for each level (*i.e.* v -test value > 2) according to a hypergeometric law (Lebart, Piron, & Morineau, 2006), are shown on the first two CA dimensions.

3. Results

Results from the sorting task were analysed in two ways: (1) at a panel level by using DISTATIS analysis for the sorting data and CA analysis for the verbalization data, and (2) at an individual level by calculating individual scores. To evaluate the generalizability of our results, each binary categorization task was performed on three sets randomly picked from a pool of wines. Our results showed that for all categorization tasks, with a few exceptions, the results obtained for the three sets were similar. All these results are presented for the individual categorization scores and the verbalization analysis but to avoid redundancy and having too many figures, only the results obtained with one wine set will be presented for the DISTATIS analysis.

3.1. Binary sorting task in the perceptual and conceptual conditions

3.1.1 DISTATIS analysis

Figs 2, 3 and 4 show DISTATIS compromise maps of the wines for respectively the grape variety, the appellation and the *lieu-dit* levels. Globally, the HAC groups showed that at the panel level, the wine labels are separated into the two *a priori* categories (Figs 2b, 2d, 2f, 3b, 3d, 3f, 4b, 4d and 4f), with an exception for the *lieu-dit* level for the novice panels (Figs 4d and 4f). However, the wines are not clearly separated into the two *a priori* categories (Figs 2a, 2c, 2e, 3a, 3c, 3e, 4a, 4c and 4e). As an example, Fig 2a and b show the first two dimensions of the DISTATIS compromise maps obtained for the expert panel in the wine (Fig 2a) and label (Fig 2b) categorization tasks at the grape variety level. In the conceptual condition, the first dimension (81.05% of variance) opposes clearly the Gamay to the Pinot Noir wines. The small size of the confidence intervals reflects a good agreement among assessors. This opposition between Gamay and Pinot Noir wines is not as clear in the perceptual condition: The first dimension explains only 46.22% of variance and the confidence intervals are much larger and tend to overlap. The HAC performed on the coordinates of the wines in the perceptual condition shows that the Gamay wine G3 is grouped with the six Pinot Noir wines. Whereas for the conceptual condition, the separation into the two *a priori* categories is quite clear. The same pattern of results is observed for the familiar novice panel (Figs 2c and 2d). For the unfamiliar novice panel, some overlap between confidence intervals are observed in the conceptual condition indicating a fuzzier conceptual representation of Gamay and Pinot Noir wines for this panel (Figs 2e and 2f).

Interestingly for the appellation level (Fig 3), a greater overlap between confidence intervals appears for experts in the conceptual condition (Fig 3b) than for the two other panels (Figs 3d and 3c). The opposite is observed for the *lieu-dit* level: Only experts were able to separate *lieu-dit* from not *lieu-dit* at the conceptual level. Important overlaps are observed for the two other panels. This suggests that only experts developed a conceptual representation of *lieu-dit* even though the size of the confidence and the inter-assessor's disagreement for wines NL3 and L3 indicates that this representation is not as clear as the one observed for the grape variety level.

3.1.2. Individual scoring analysis

The individual score analysis shows the same global trend as observed through the DISTATIS analysis, but important inter-individual differences appear even in the conceptual condition. For instance, despite a clear separation of the Pinot Noir and the Gamay labels at a panel level, only 25% of all the assessors have perfectly sorted the labels into the two expected categories.

As expected, the three-way ANOVA showed:

- A significant main effect of expertise level ($F[2, 914] = 15.2, p < 0.0001$). The Duncan test indicates that on the whole, the experts (mean = 2.4) significantly outperformed the two groups of novices. However, contrary to our hypothesis, no significant difference was observed between both novice types (mean = 2.1 and 1.9 for familiar and unfamiliar novices respectively).
- A significant main effect of the level of categorization ($F[2, 914] = 15.1, p < 0.0001$). The Duncan test showed that significantly higher categorization scores were obtained for the more general categorization level, grape variety (mean = 2.4) followed by the appellation level (mean = 2.1) which was significantly different from the more specific categorization level, *lieu-dit* (mean = 1.7).
- A significant main effect of condition ($F[1, 914] = 234.5, p < 0.0001$): Higher categorization scores were obtained in the conceptual (mean = 3.0) than in the perceptual (mean = 1.4) condition.

These main effects, however, should be interpreted with caution as all interactions were also significant. The effect of expertise depends both on the level of categorization ($F[4, 914] = 4.4, p < 0.01$) and on the condition ($F[2, 914] = 5.7, p < 0.01$) and also on the interaction between these two factors ($F[4, 914] = 3.2, p < 0.05$). The effect of expertise is stronger in the conceptual condition than in the perceptual condition. In the perceptual condition, the superiority of experts over novices (familiar and unfamiliar) holds only for the grape variety and to a lesser extent the *lieu-dit* level. No effect of expertise was seen for the appellation level (Fig 5a). This goes against our hypotheses as we expected the effect of expertise to decrease with the specificity of the categories. In the conceptual condition (Fig 5b), familiar novices are closer to experts, both having higher scores than unfamiliar novices, whereas in the perceptual condition they are closer to unfamiliar novices. Finally, the effect of categorization level holds only for the conceptual condition. The two more general levels (grape variety and appellation) led to higher scores than the most specific level (*lieu-dit*) in the conceptual condition for the novices only. No difference was observed in the perceptual condition.

3.2. Verbalization

In the perceptual condition, a total of 92 terms was elicited after lemmatization for all panels, all levels and all sets. Fig 6 shows the projections of the 92 terms on the first two dimensions

of the CA (82.45% of the variance). Although some terms are used by all panels, such as *fruity*, *body*, *aroma*, *bitter*, *correct*, and *pronounced*, other terms are specific to each type of panel. The first dimension (67.33% of variance) opposes a basic sensory vocabulary generated by the two novice panels (on the right) to a more specialized sensory vocabulary generated by the expert panel (on the left). The expert panel used specific terms like *woody*, *tannins*, *complexity*, *lively*, *supple*, *spicy*, and *warm*. Among these specific terms, some terms like *Brett*, *oxidation-reduction*, *ethyl*, and *fault* correspond to wine faults. The second dimension (15.12% of variance) opposes the two groups of novices. The familiar novices, like experts, generated specialized terms like *thick*, *harsh*, *aggressive*, *green*, *persistence*, *nut*, *floral*, and *straightforward* while the unfamiliar novices used more basic terms such as *strong*, *dry*, *full-bodied*, *rich*, *pungent*, *aftertaste*, and *rough*. Interestingly, the results also showed that, for a given panel, the terms used do not depend on the level of categorization (Grape variety, Appellation, *Lieu-dit*). This last result suggests that panelists used the same strategy to perform the sorting task independently of the category levels.

In the conceptual condition, a total of 116 terms was obtained after lemmatization for all panels, levels, and sets. Fig 7 shows the projections of the 116 terms on the first two dimensions of the CA (55.64% of the variance). Contrary to what was observed in the perceptual condition, the level of categorization impacted the terms used to describe the groups formed in the conceptual condition. The first dimension (30.09% of variance) opposes the terms used for the grape variety level to the terms used for the two other category levels. This distinction was particularly true for experts who used the same terms to describe the wines from the appellation and the *lieu-dit* levels, but different terms to describe the wines from the grape variety level. The second dimension (25.55% of variance) opposes the experts to the two groups of novices. Although the difference between the three panels is not as clear as in the perceptual condition, some terms were more specific to certain panels. Among the terms that characterized the most each panel (hypergeometric law, alpha risk =5%), the experts use both visual terms (*classic*, *traditional*, *trendy*, and *prestige*) and specific terms about the wines that are related to the *a priori* categories (*climat*, *cuvée*, *lieu-dit*, *cru*, and *Terra Vitis*). In contrast, the familiar novices used more the label information: They looked for information on the type of wine and producer (*grape variety*, *bottling*, *establishment*, *producer*) and were also attracted by visual cues (*busy*, *readable*, *standard*). The unfamiliar novices seemed to search for all the clues they could find on the labels like the back label information (sensory description, food pairing (*occasion*, *meal*)), the presence of *medal*, of *legal mention*, the visual (*austere*, *strict*, *serious*, *festive*, *authentic*, and *refined*), and the type of appellation, without necessarily making distinctions between the relevant and the irrelevant information.

To sum up, the verbalization task highlighted the strategies used by the three panels to sort the wines and the labels. The words generated show that, in the perceptual condition, the assessors focused mainly on their sensory perception of the wines without making any inference about their origin for instance, whatever the level of expertise. An effect of expertise is observed on the type of terms used: The experts used a specialized sensory vocabulary while the unfamiliar novices used a global vocabulary to describe the wines. The

familiar novices are intermediates for the vocabulary used. A higher effect of expertise is observed for the conceptual condition.

4. Discussion

Based on the literature, our main hypothesis was that the level of expertise would considerably affect the wine categorization for the perceptual condition (wines), and for the most specific levels of categorization (appellation and *lieu-dit*). We expected that, for the perceptual condition, the experts would rely more on top-down processes based on their experience and knowledge about the wines, than bottom-up processes based on their sensory perception of the wines. We expected the opposite result for the two novice panels. For the conceptual condition (labels), we expected a lesser effect of the level of expertise than that for the perceptual condition. Our second hypothesis was that the experts would use more the *a priori* categories, through their professional background and exposure to Beaujolais wines, than the familiar and unfamiliar novices with a lower level of expertise and/or familiarity with the Beaujolais wines.

4.1. Blind wine tasting categorization: only perceptual?

For the perceptual condition, the effect of expertise was less strong than we expected. Concerning the grape variety level, our results are not fully in line with the assumption that experts have developed a mental representation of wines based on grape variety prototypes, through their prior experience and knowledge with wines (Ballester et al., 2008; Hughson & Boakes, 2002; Solomon, 1997). However, in our study, no information about the wines or the categories were provided to the assessors, that could explain the difference observed between our study and the studies mentioned previously. We expected that the expert panel would spontaneously use their mental representation of grape variety to interpret the wine sensory characteristics they perceived in the perceptual condition, leading them to categorize the 12 wines according to the grape variety. Our results for the three sets showed only a tendency to categorize the wines by grape variety, but this pattern of categorization was not systematic for each expert.

For the two most specific levels, the experts did not categorize the wines into the *a priori* categories (reminder: Morgon vs. Régnié for the appellation level, and Morgon vs. Morgon *lieu-dit* for the *lieu-dit* level). For all levels, the descriptions of the groups of wines used by the three expert panels showed that they mainly used their sensory perception of the wines as criteria. Whatever the level of categorization, it seems that experts did not spontaneously activate a wine prototype in memory to make inferences about the properties of the wines they tasted (no name of grape variety, origin, or type of winemaking). Instead, the results of the verbalization show that they rather looked for the presence of wine faults among the samples. These results indicate that when experts have no information about the wines or about the aim of a tasting, they use an analytical approach to categorize the wines. As they were looking for specific characters based on their knowledge and past experience, the famous wine tasting definition from Ribéreau-Gayon takes on its full meaning in our results: “*Wine tasting is to taste a wine with care in order to appreciate its quality; to submit it to examination by our senses, in particular those of taste and smell; to try and understand it by discovering its*

various qualities and faults and putting them into words. It is to study, analyze, describe, define, judge and classify.” (Peynaud & Blouin, 2013, p. 1). It is important to note that experts used many wine fault terms in their verbalizations. However, a closer look to the individual results reveals that experts did not agree on which wines were faulty or on which faults they found in a given wine. That behavior is probably not due to the wines themselves, but rather to the type of experts we recruited. Indeed, a major part of the experts who participated in our study are used to characterize wines from other research studies, for which a judgment about different wine faults is very often asked. So, this routine, gained for many years, might have been applied to the binary sorting task. The presence of wine faults constituted the main wine categorization criterion for more than half of our experts, whatever the set of wines or the categorization level (five of them have systematically sorted the three sets of wines according a fault criterion). However the lack of consensus for the given faults (e.g. some wines were considered as “fault” for some experts, but the same wines were also considered as “no faults” for others, and different types of faults were identified for a same wine), leaves us to think that some of these experts, seek by any means a fault, where maybe there is none. In agreement with this interpretation, at the end of the binary task, some of experts told us that they tried to guess the purpose of the study. It leads us to think that it is probably necessary for them to set a goal prior to categorize the wines, when no information or context is provided. This phenomenon was also reported in a previous study on wine label categorization (Honoré-Chedozeau et al., 2017).

Our study does not imply that experts are not able to categorize wine according to grape variety. Rather it suggests that in absence of specific information, wine variety is not the most salient criteria. In this regard, a recent study on the sensory characterization of 138 South American monovarietal red wines by ten sommeliers showed that about one third of them retrieved the country of origin and the grape variety of the wines (Llobodanin et al., 2014). In this study, the sommeliers were previously informed that they have to evaluate South American red wines from six different grape varieties (Cabernet Sauvignon, Carménère, Malbec, Merlot, Tannat and Syrah) produced in four different countries of origin (Argentina, Brazil, Chile and Uruguay). So, they were somehow helped for retrieving the correct grape variety and country of the wines they evaluated, even if it is far for being easy for all the sommeliers. One could question whether those sommeliers would have retrieved the “correct” answers without any prior information about the wines.

An analysis of the descriptions of each group of wines of the experts reveals that rather than activating a prototype, experts activated a wine tasting script. For instance, one expert wrote “Aromatic and fruity wines. Supple in the mouth. Harmonious finish”, showing different steps during his wine tasting. Another expert wrote each description as a list of three dashes, indicating a specific step for each dash such as:

- The nose is often expressive, simple (sweet, rose, chocolate)
- « Stiff » and cold tannins
- Heat on the finish

Through those descriptions, we can observe that a first step concerned the perceptions “in the nose”, then a second one showed those “in the mouth”, and a final one concerned those after

spitting out the wine. Many of those descriptions are structured like that, with some “*in the nose*” and “*in the mouth*” steps like “*balanced nose with empyreumatic and fruity aromas. Pleasant on the palate, thin, round*” or “*fruity nose (red fruits) + sweet, acidity in mouth + astringent + less intensive but long aftertaste*”.

The same script seems to be used whatever the level of categorization. The script-theory was initiated by Schank & Abelson (1977) from the computer science and psychology, suggesting that our knowledge would be organized into a lot of stereotyped situations from routine action like “*going to a restaurant*”, “*taking a bus*” or “*visiting a doctor*” (Bower, Black, & Turner, 1979). Abelson (1981) defined a script as “*a standard sequence of events characterizing typical activities in a restaurant from the point of view of the customer*” (p.1) in the case of a “*going to a restaurant*” activity. That is, a script is a sort of structured list of different steps to make routine actions in a specific situation, which is learnt from past experience (Bower et al., 1979). That kind of “*schema*” could help people for understanding and for realizing routine actions in specified conditions by providing and following a sort of active procedure or a program, as it is the case for the development of computer programs in artificial intelligence (Abelson, 1981; Dreyfus, Dreyfus, & Athanasiou, 1988; Rumelhart, 2017). Based on the wine descriptions, we can imagine a “**wine tasting**” script that our experts could have activated in memory during the tasting that deriving from their wine experience, by following those overall recognized steps:

- **1/ Smelling the wine: is there a fault?**

- o Yes: I describe the faults (e.g. dusty, acetate, Brettanomyces)
- o No: I describe the odours through orthonasal olfaction (e.g. rose, chocolate, empyreumatic, fruity, red fruits)

- **2/ Tasting the wine: is there a fault?**

- o Yes: I describe the faults (e.g. corky, Brettanomyces, oxydised)
- o No: I describe the flavours and the mouthfeel characteristics (e.g. astringent, round, silky tannins, acid, supple)

- **3/ Judging the global harmony of the wine (e.g. well-balanced, harmonious, length)**

This potential script follows a kind of “*wine tasting process*” that is retrieved in the sensory descriptions of experts that often going from “*the [...] colour*”, then “*in the nose*” to “*in the mouth*” statements (Gawel, 1997; Lawless, 1984). For instance, we can find this kind of wine tasting note for a Morgon wine: “*A garnet red colour. The nose opens up with undergrowth and fresh fruit notes. Supple, round, without roughness, the mouth makes you want to serve the bottle in the year.*” (Guide Hachette des vins 2012, 2011, p. 177). That wine tasting process is also reinforced by wine tasting books (Jackson, 2017; Klem, 2009; Peynaud & Blouin, 2013; Sato, 2012; Zrally, 2014), wine training courses or even through wine tasting sheets (Danner et al., 2017; Gomes, José-Coutinho, da Silva, & Ricardo-da-Silva, 2016; Loureiro, Brasil, & Malfeito-Ferreira, 2016; Organisation Internationale de la Vigne et du Vin, 2009; Thuillier, Valentin, Marchal, & Dacremont, 2015). Our results suggest to us that their wine experience and wine tasting training, and even the wine tasting context of our experiment, lead our experts to activate this hypothesized script instead of a potential prototype.

Concerning the novices, they also based their categorization on their sensory perceptions without a tendency to sort the wines into the *a priori* categories, whatever the level of

categorization. However, we notice an effect of expertise in the vocabulary used to describe the groups of wines: the novices used a more basic vocabulary than that of experts, as shown in the literature (Chollet & Valentin, 2000; Lawless, 1984; Sauvageot, Urdapilleta, & Peyron, 2006; Solomon, 1997; Valentin, Chollet, & Abdi, 2003). For the familiar novices, we identified a trace of the previous wine tasting script through some descriptions of each group of wines, with the use of “*in the nose*” and “*in the mouth*” sentence segments or “*odour*” and “*taste*” terms. For instance, one wrote “*Those are perfumed, red fruit or prune notes and pleasant in mouth.*”, and another wrote “*Aggressive nose. Acid taste*”. So, like the experts, the familiar novices could have activated a similar and potential “wine tasting” script, which is less technical, less precise and not “fault” oriented. On the contrary, the descriptions of the unfamiliar novices did not show a trace of any wine tasting script: the terms used are globally basic and often based on liking. For instance, one wrote “*I like it*” and another one “*Light wines with a discrete aftertaste*”.

4.2. Wine label categorization: a question of knowledge

For the conceptual condition, although the results globally showed, at the panel level, a categorization into the *a priori* categories whatever the level of expertise (with the exception of the *lieu-dit* level), the results from the average scores at the individual level showed that the separation of the labels into the *a priori* categories is far from being systematic and/or obvious for each assessor, even for the experts. That result suggests the use of different strategies and criteria to sort the labels according to the level of expertise of the assessors, indicating different mental representations of the wines. The verbalization provided by the experts showed that they used top-down processes, based on their knowledge about the wines, to categorize the wines for each level into the expected *a priori* categories. By contrast, the familiar novices used more bottom-up processes than the experts, based on label information, to sort the wines and, the unfamiliar novices used mainly bottom-up processes in their categorization, whatever the level. Those strategies could explain why the novice panels did not sort the wines from the same appellation into the *lieu-dit* criterion, by probably a lack of knowledge or of meaning about the information they read. As shown in our previous study, the novice panels read carefully all the information on the wine labels for helping them in their categorization (Honoré-Chedozeau et al., 2017). The task was perhaps difficult to sort 12 wines within the same appellation, and the label information could not be very helpful if we did not know which information is relevant, or even the meaning of that different information. The novice could be rapidly lost among the highest or the lowest level of information given by the labels. In contrast, the task was perhaps easier for most novices for the appellation level. In fact, only two appellations were represented, less than for the grape variety level. So, the names of the two PDOs “Morgon” and “Régnié” were put forward in comparison with the other label information, that probably leading the novices to separate the labels according to those names. This obviousness of information could explain why there is a very little variability for the appellation level at the panel level compared to the grape variety level among the novice panels.

Globally, each panel used more different words for the wines from the grape variety level than for the appellation and the *lieu-dit* level. In addition, the high inter-individual variability shown in Figs 3b, 4b, 4d and 4f suggest us to think that different strategies of categorization were used among experts: one part of experts may use only visual criteria, and the other part may use only their knowledge to categorize the wines. Likewise, the type of information about the grape variety, the winemaking, and the origin is not always indicated on the labels, that could explain why the use of these specific terms are not systematically mentioned and/or shared by the novice panels.

5. Conclusions

Contrary to our main hypothesis, results showed a lesser effect of expertise for the perceptual condition than for the conceptual one. Our results showed that, whatever the level of categorization and the level of expertise, the assessors did not make inferences about the *a priori* wine categories when they taste the wines of the different sets. Nevertheless, there is an effect of expertise in both the categorization and the vocabulary used to describe the groups of wines. So, when the experts have to categorize spontaneously the wines without any information, their perception seems to be more directed by bottom-up processes, based on sensory descriptions, rather than top-down processes, based on knowledge and experience, whatever the level of categorization. It is important to note that contrary to other studies in the literature, we did not seek for the representativeness of the wines during the selection of the wines for each *a priori* category, as we wanted to know if the wines could be retrieved from the chemosensory perceptions without any prior information. Part of our results could have thus its source in this random wine selection. That could also explain why the grape variety categorization was not as obvious for the expert panels, as we expected. By taking into account the very fine level of categorization we studied, the differences of the selected wines between the *a priori* categories were probably not salient enough to be perceived spontaneously by the assessors without any clues, whatever their level of expertise. Moreover, the lack of visual information probably made even more unlikely the categorization into the expected grape variety categories (since young Gamay and young Pinot noir have quite different colours). This lack of visual information may explain why the concepts or prototypes of Gamay or Pinot noir might not have been activated during the wine tastings, which was only based on chemosensory perceptions. For the PDO and *lieu-dit* levels, it would be reasonable to think that visual information will be of little help in finding the *a priori* categories since these wines came from the same grape variety and were from the same vintage. Concerning the vocabulary, the experts used a more specialized wine sensory vocabulary to describe the wines for the perceptual condition than the novices, as shown in the literature. In contrast, the expert conceptual categorization seems to be mostly driven by top-down processes while the novice conceptual categorization seems to be mainly based on the type of information that they read on the label whatever their degree of relevance. These strategies lead therefore to a little effect of expertise for the wine labels when the level of categorization becomes finer.

Taking all these results into account, it would be interesting to compare our non-directed binary task with a directed categorization task with the same wines (i.e. the same binary

sorting task with the name of the *a priori* categories), in order to know if the assessors categorize the wines into the *a priori* categories when they are provided with an information allowing for the activation of varietal concept/prototypes. These tasks could be carried out in dark and clear glasses for further evaluation of the impact of colour. Finally, this work suggests a construction of different perceptual and conceptual mental representations of the wines, contrary to the hypotheses found in the literature. The conceptual representation seems to be based on *a priori* wine categories as found in the wine books while the perceptual representation seems to be based on sensory similarities of the wines, without a clear link with the *a priori* categories. This result suggests that the *a priori* categories are not spontaneously activated for the perceptual condition without information about the wines. For the experts, when they taste wines, they looked at the fault, which seems to be an important activity that goes beyond the *a priori* wine categories. Based on Jose-Coutinho *et al.*'s work (2015), it would be also interesting to know further about the experts' representation of wines by answering a same wine sensory questionnaire in two conditions: a condition for which the experts should answer from memory compared to a condition for which they should answer by tasting.

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Figure captions

Fig. 1: Schematic diagram of the procedure used for each wine set

Fig. 2: DISTATIS compromise maps of the wines with 95% tolerance ellipses for the **grape variety** level and the expert panel for a) the perceptual condition (n=19) and, b) the conceptual condition (n=13); the familiar novice panel for c) the perceptual condition (n=20) and, d) the conceptual condition (n=12), and the unfamiliar novice panel for e) the perceptual condition (n=20) and f) the conceptual condition (n=18); **P**: Pinot Noir category, **G**: Gamay category. The dotted ellipses correspond to the two clusters resulting from the HAC.

Fig. 3: DISTATIS compromise maps of the wines with 95% tolerance ellipses for the **appellation level** and the expert panel for a) the perceptual condition (n=19) and, b) the conceptual condition (n=13); the familiar novice panel for c) the perceptual condition (n=20) and, d) the conceptual condition (n=12), and the unfamiliar novice panel for e) the perceptual condition (n=20) and f) the conceptual condition (n=18); **M**: Morgon PDO category, **R**: Régnié PDO category. The dotted ellipses correspond to the two clusters resulting from the HAC.

Fig. 4: DISTATIS compromise maps of the wines with 95% tolerance ellipses for the **lieu-dit level** and the expert panel for a) the perceptual condition (n=19) and b) the conceptual

condition (n=13); the familiar novice panel for c) the perceptual condition (n=20) and, d) the conceptual condition (n=12), and the unfamiliar novice panel for e) the perceptual condition (n=20) and f) the conceptual condition (n=18); **L**: *Lieu-dit* category, **NL**: Not *Lieu-dit* category. The dotted ellipses correspond to the two clusters resulting from the HAC.

Fig. 5: Interaction plots with standard errors of Expertise*Level for the a) perceptual condition and the b) conceptual condition

Fig 6: Graphical representation of the terms used to describe the wines for each type of panel, each level and all sets on the first two dimensions on the CA; **PG**: grape variety level; **MR**: appellation level; **LD**: *lieu-dit* level; The colour terms represent the terms that are only significant for the corresponding panel (experts in brown, familiar novices in pink, and unfamiliar novices in green). The black terms are shared by two or all the panels.

Fig 7: Graphical representation of the terms used to describe the wine labels by each type of panel for all levels and sets on the first two dimensions on the CA; **PG**: grape variety level; **MR**: appellation level; **LD**: *lieu-dit* level; The colour terms represent the terms that are only significant for the corresponding panel (experts in brown, familiar novices in pink, and unfamiliar novices in green). The black terms are shared by two or all the panels.

Table captions

Table 1: Overview of the selected wines for each set of the grape variety and the *lieu-dit* levels.

Table 2: Panel characteristics.

Table 3: Wine drinking habits of the novice panels for each set.

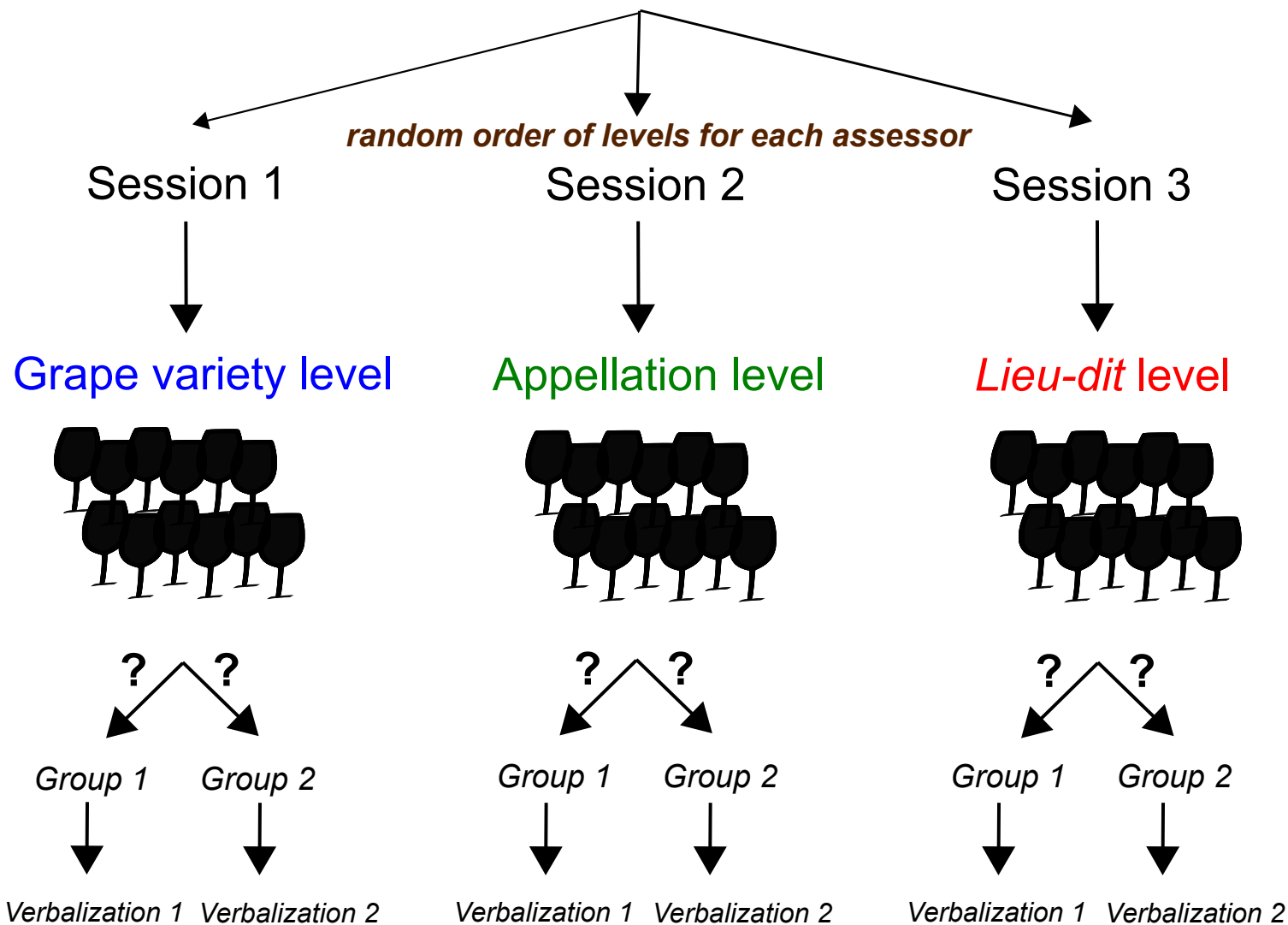
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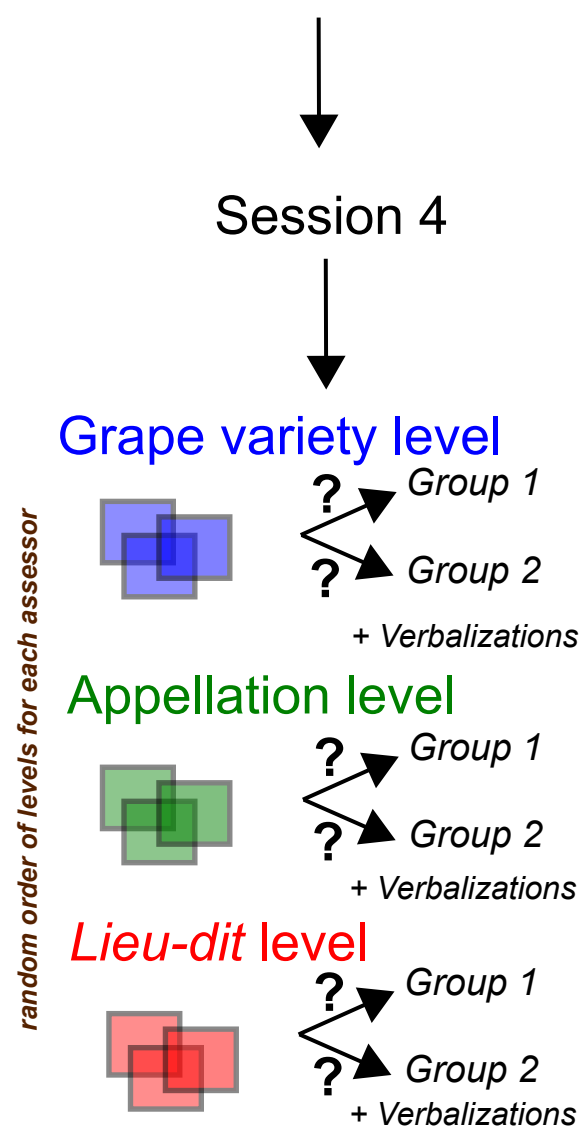
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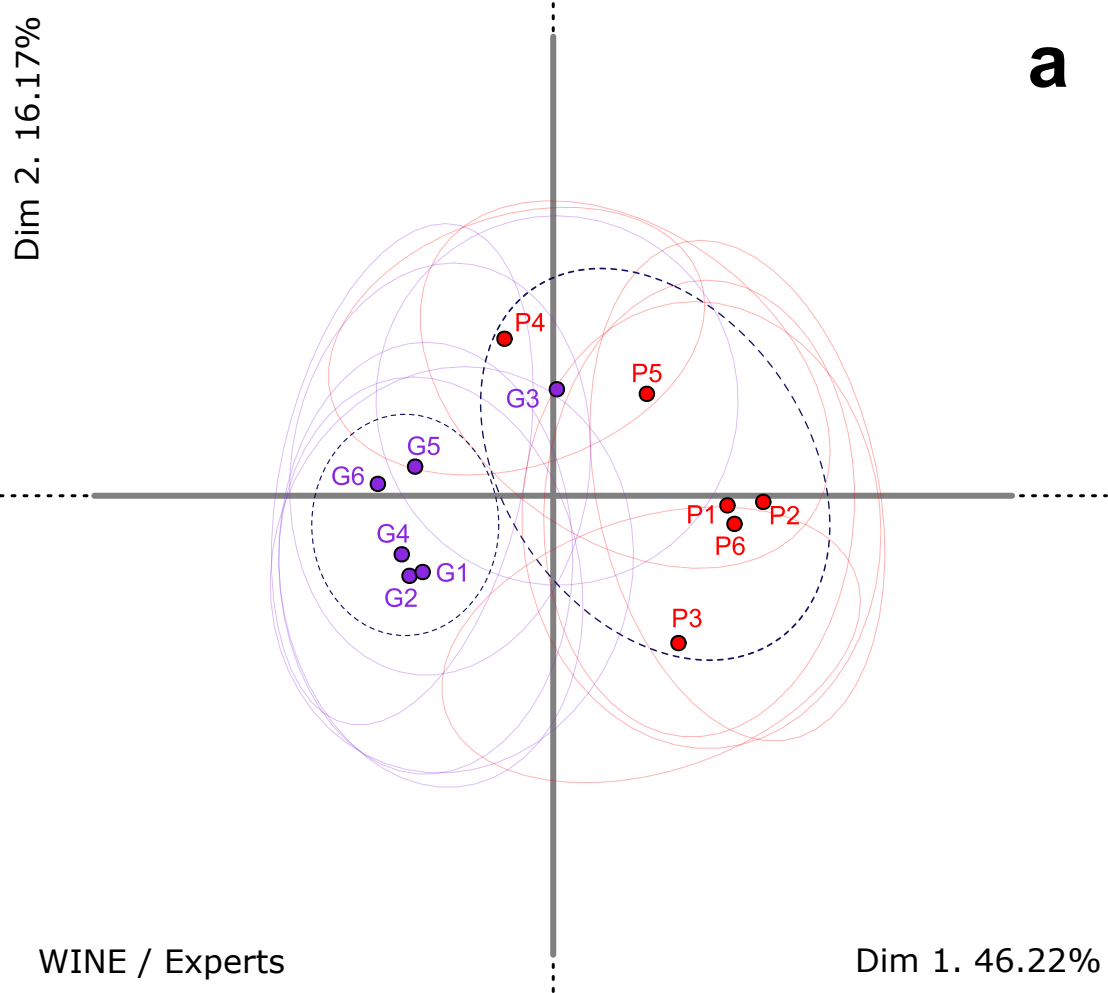
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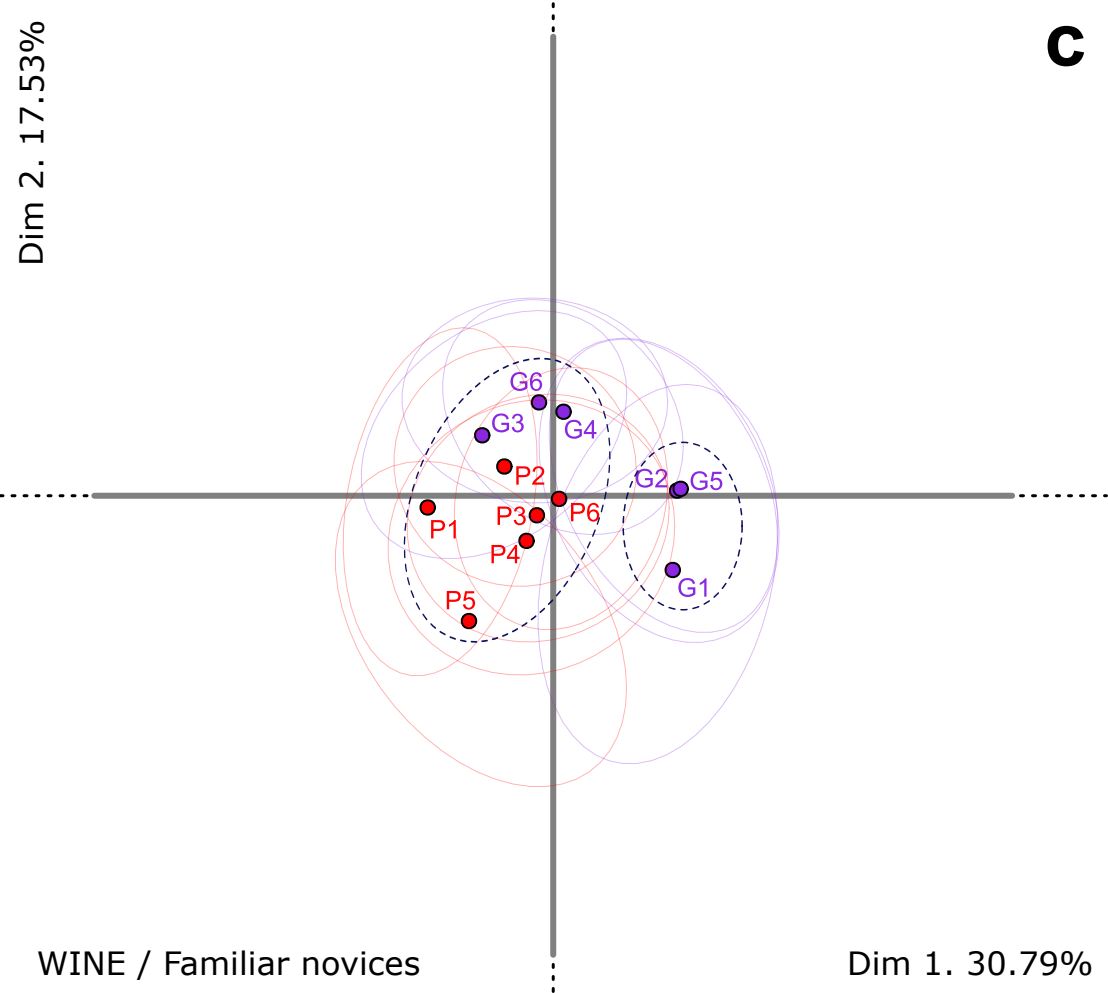
Perceptual condition

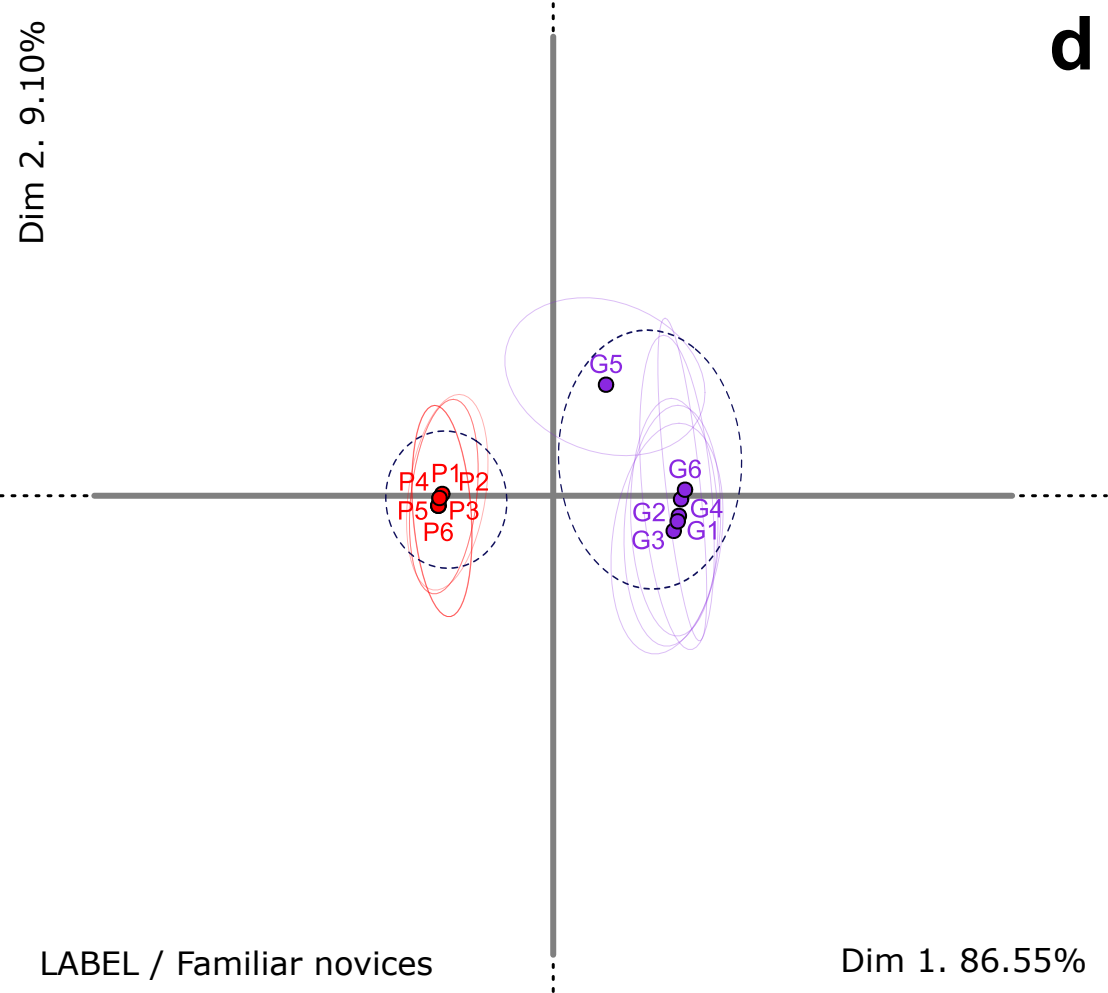


Conceptual condition



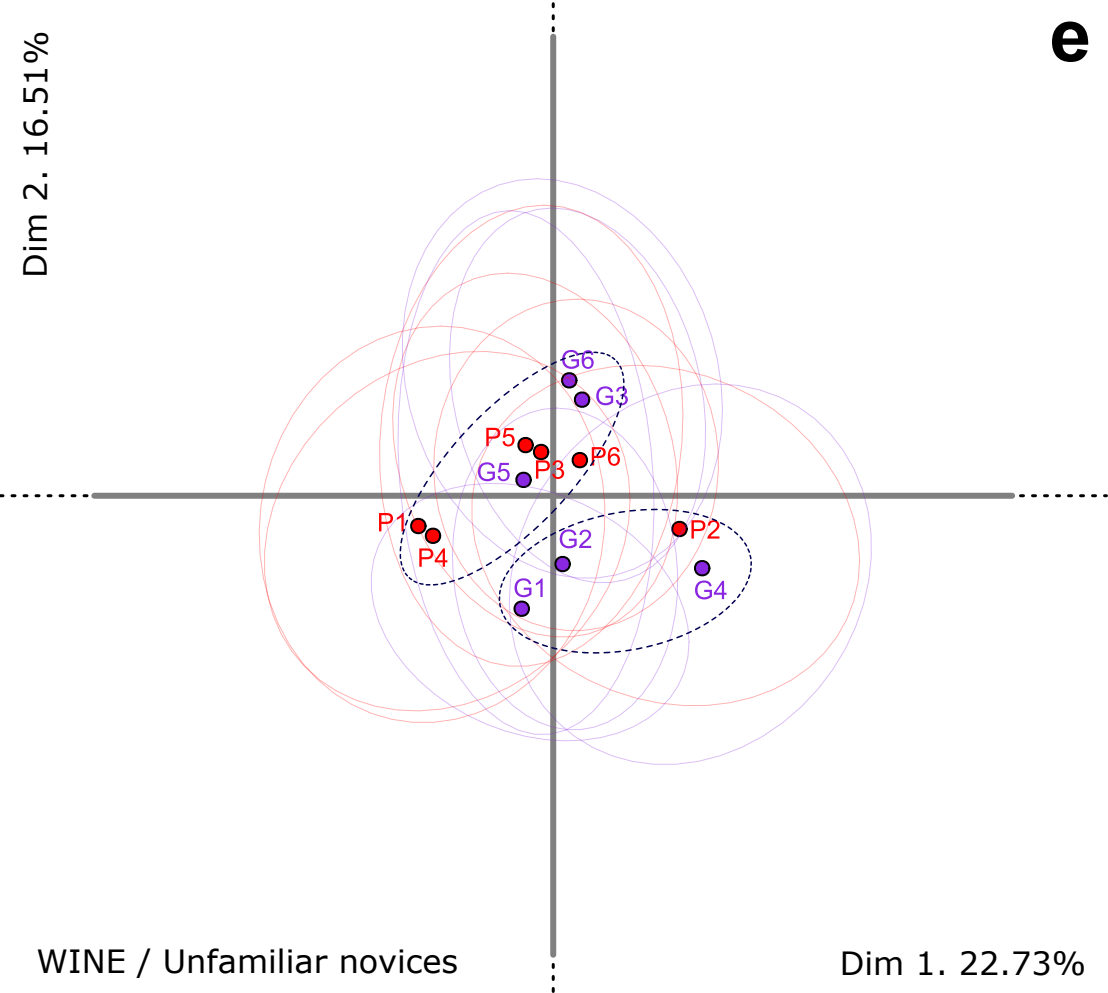


C

d

e

Dim 2. 16.51%

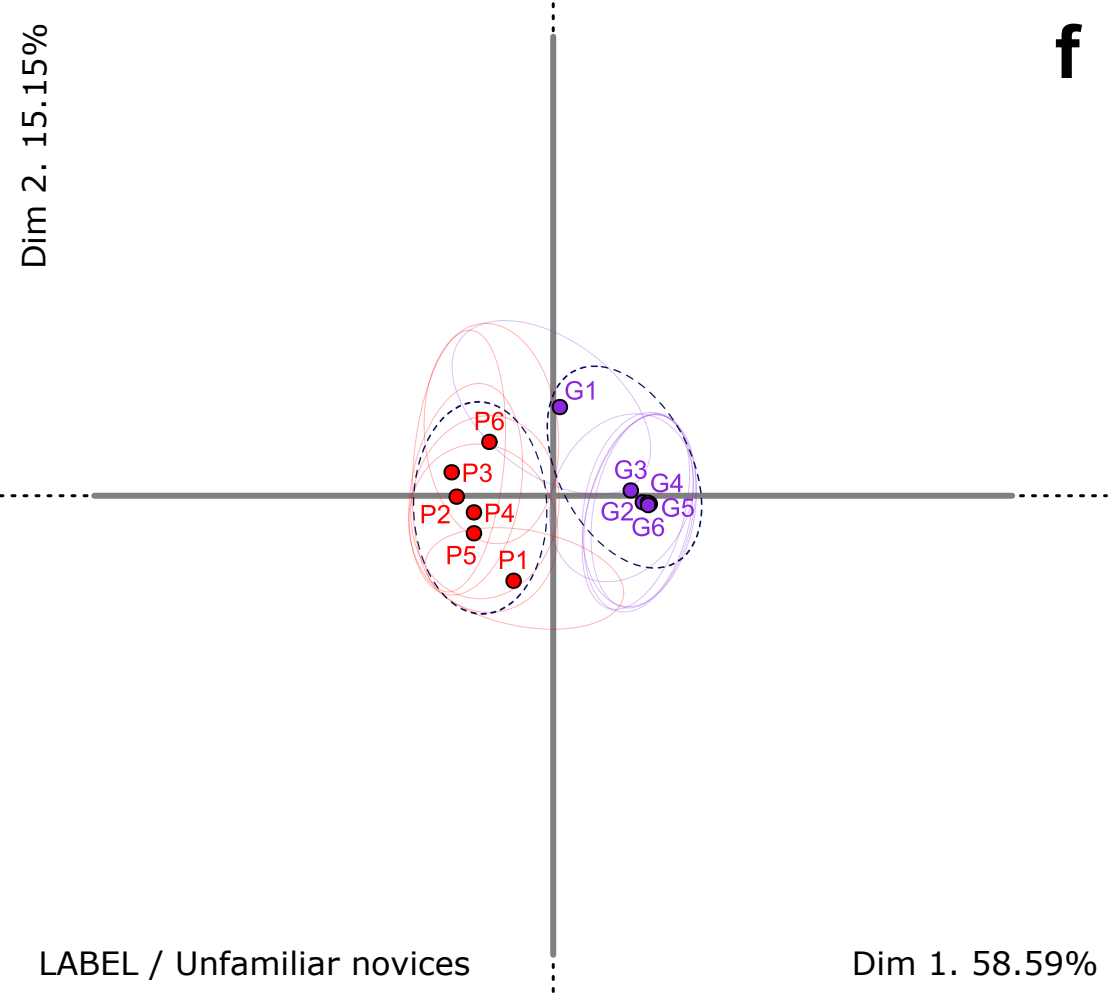


WINE / Unfamiliar novices

Dim 1. 22.73%

f

Dim 2. 15.15%

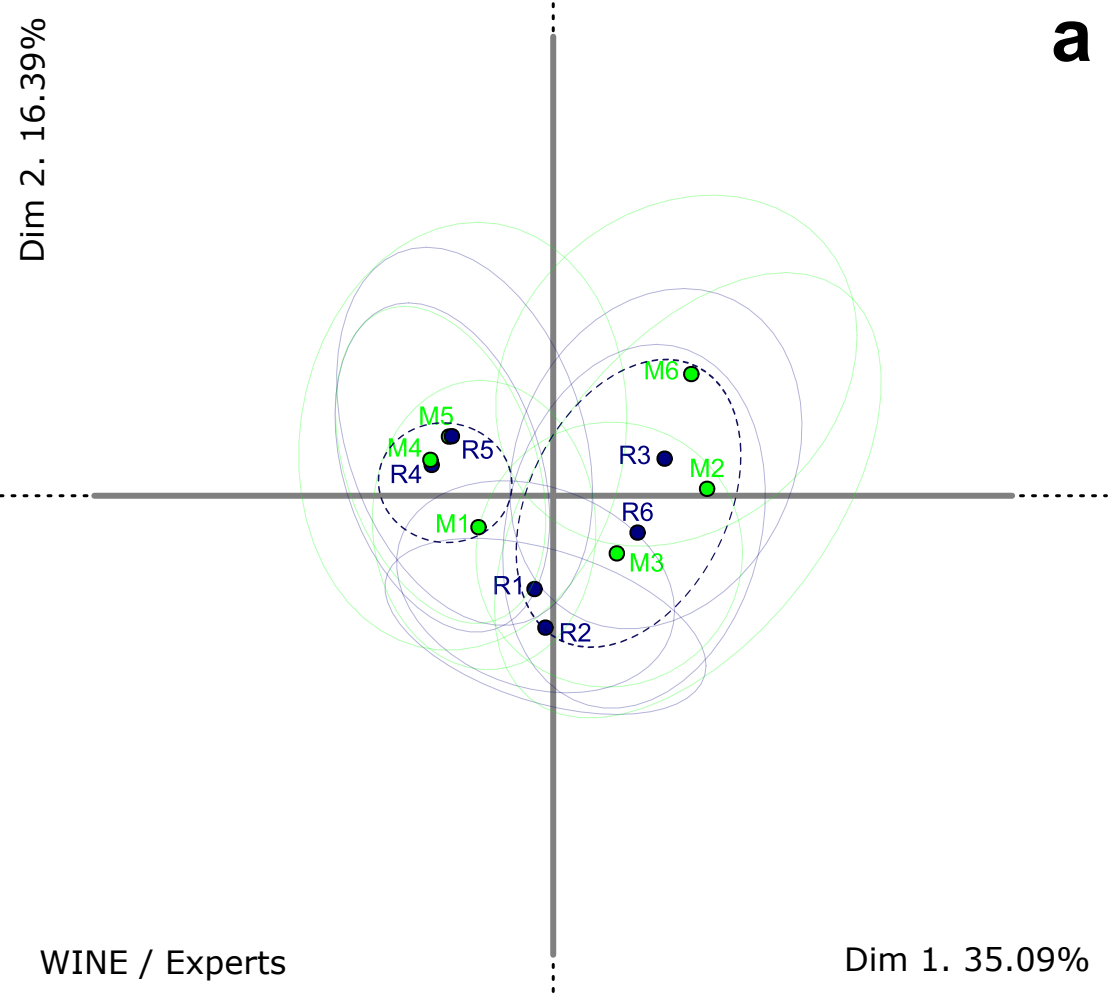


LABEL / Unfamiliar novices

Dim 1. 58.59%

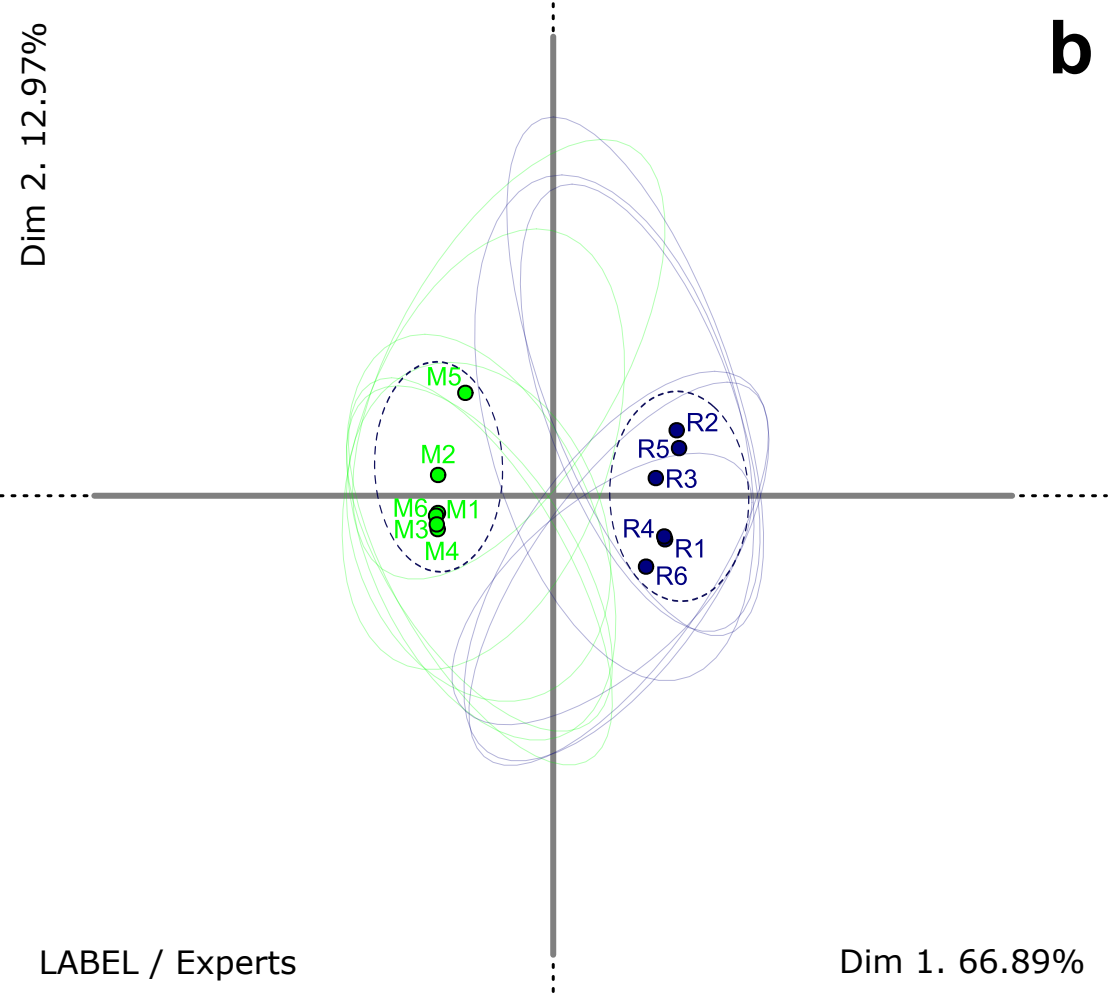
a

Dim 2. 16.39%



WINE / Experts

Dim 1. 35.09%

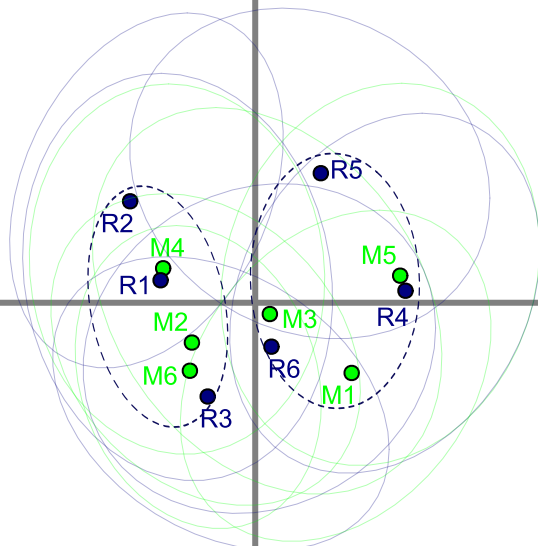
b

C

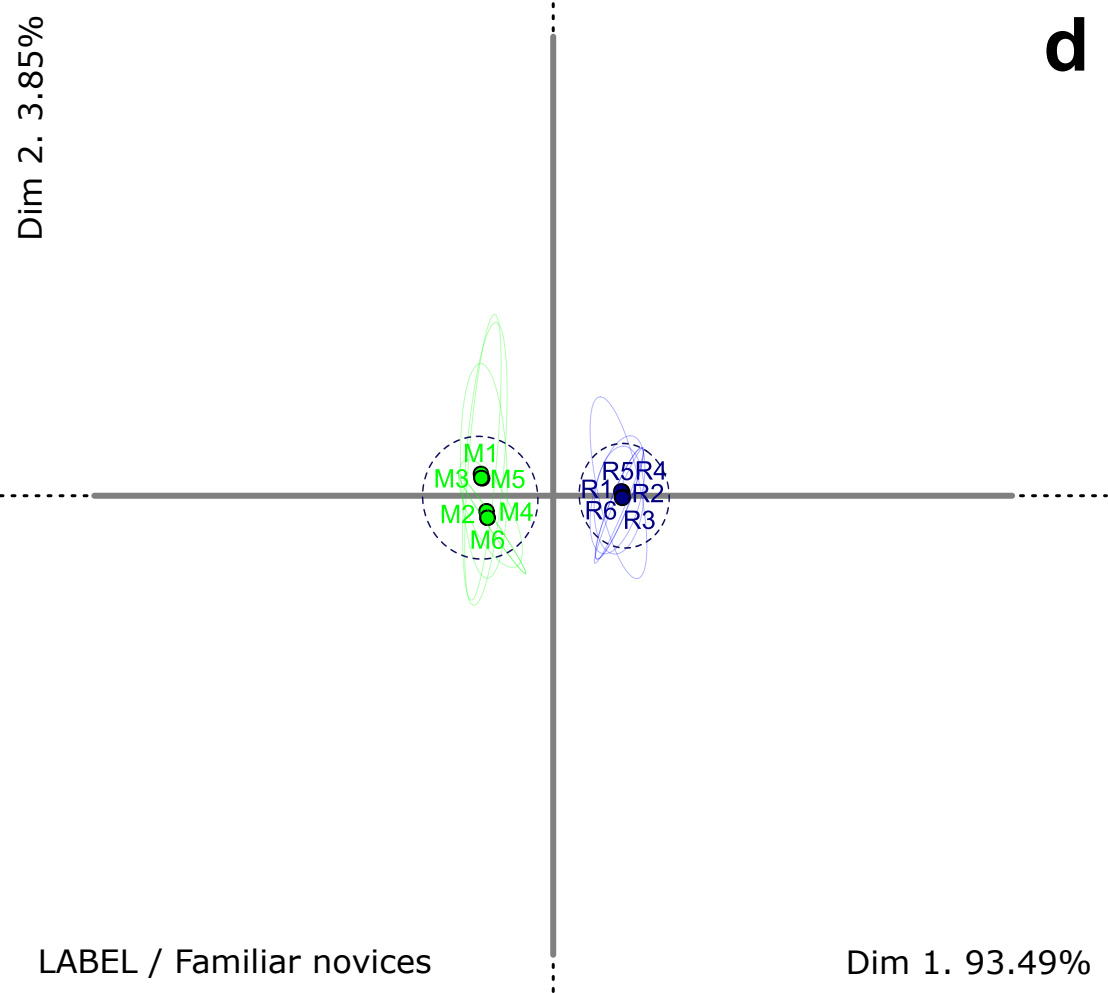
Dim 2. 15.16%

WINE / Familiar novices

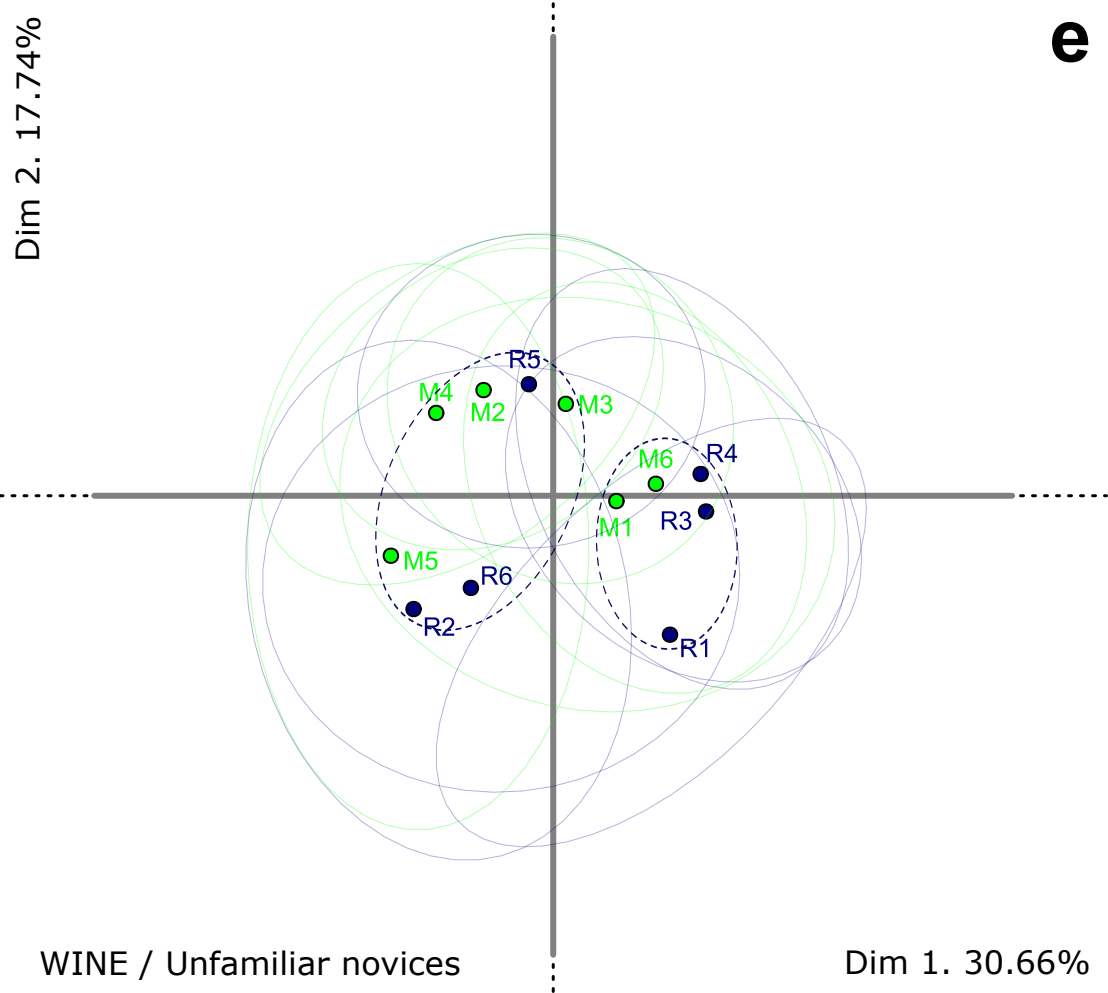
Dim 1. 29.76%



d

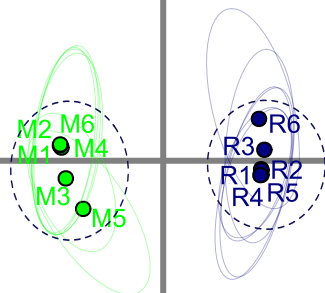


e



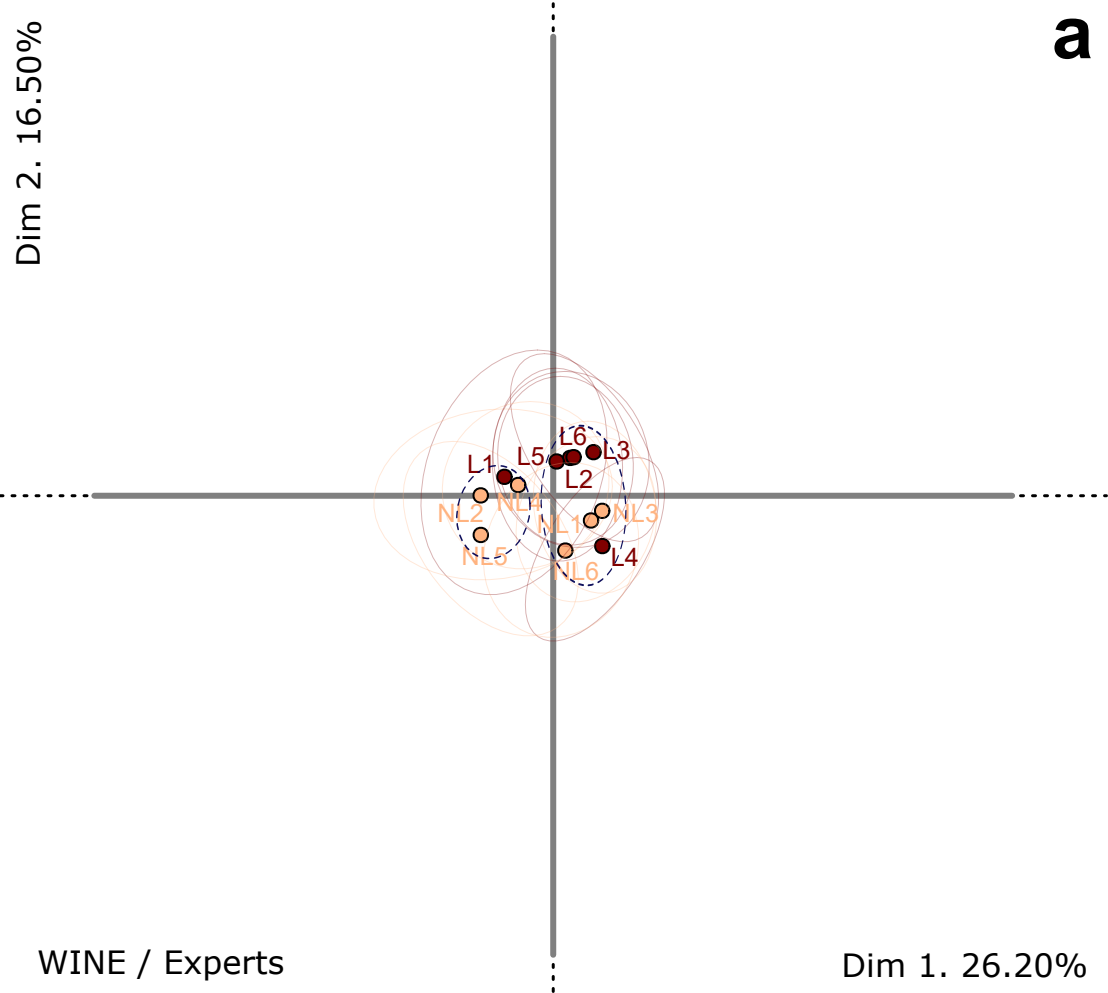
f

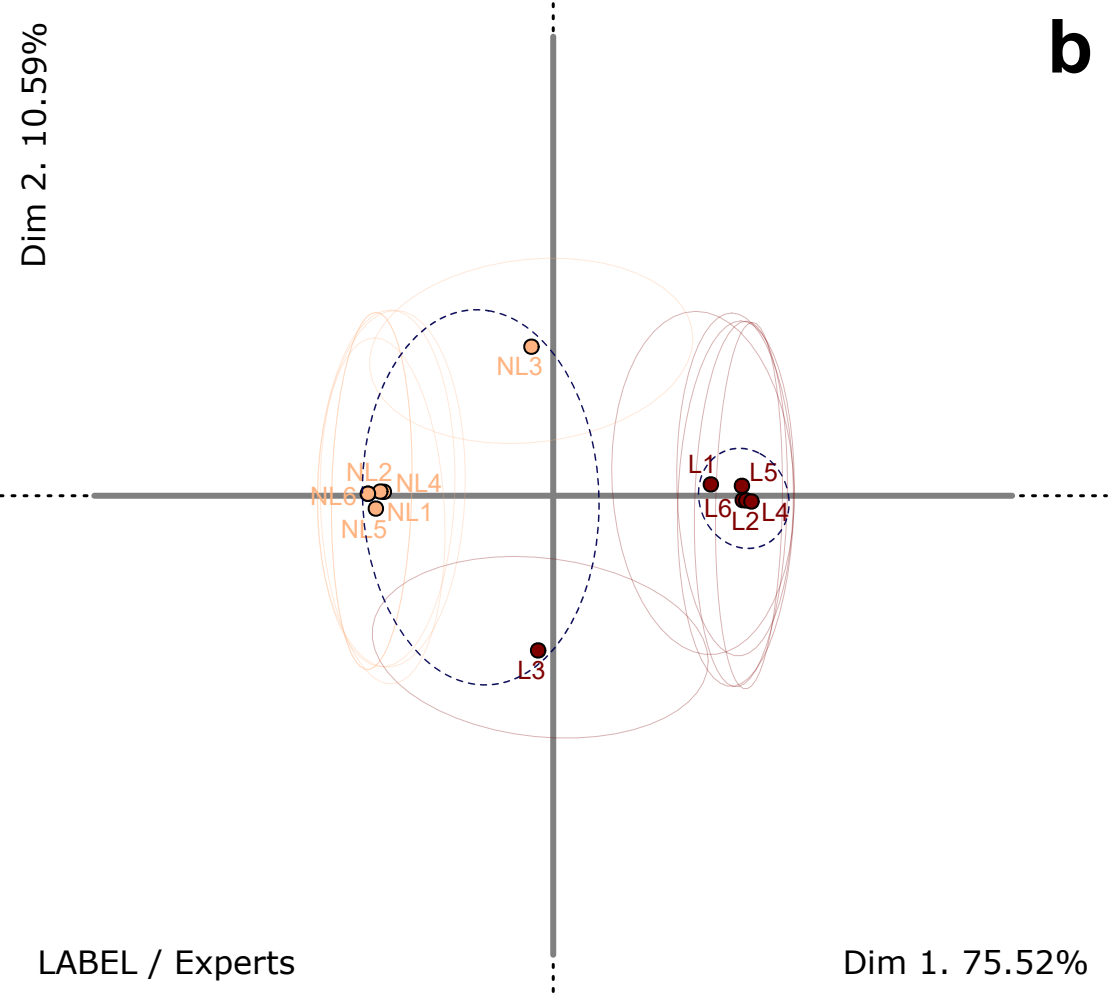
Dim 2. 4.52%



LABEL / Unfamiliar novices

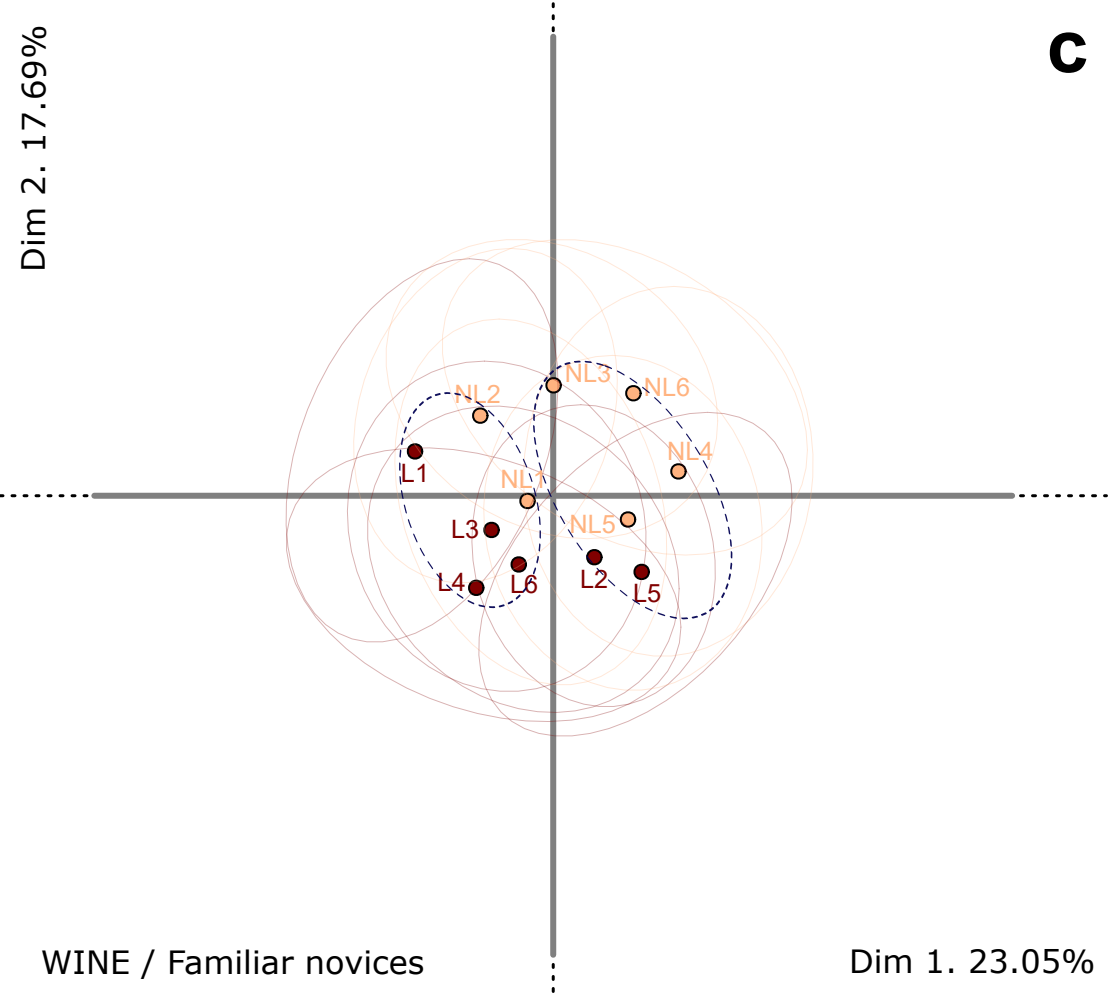
Dim 1. 87.90%

a

b

C

Dim 2. 17.69%

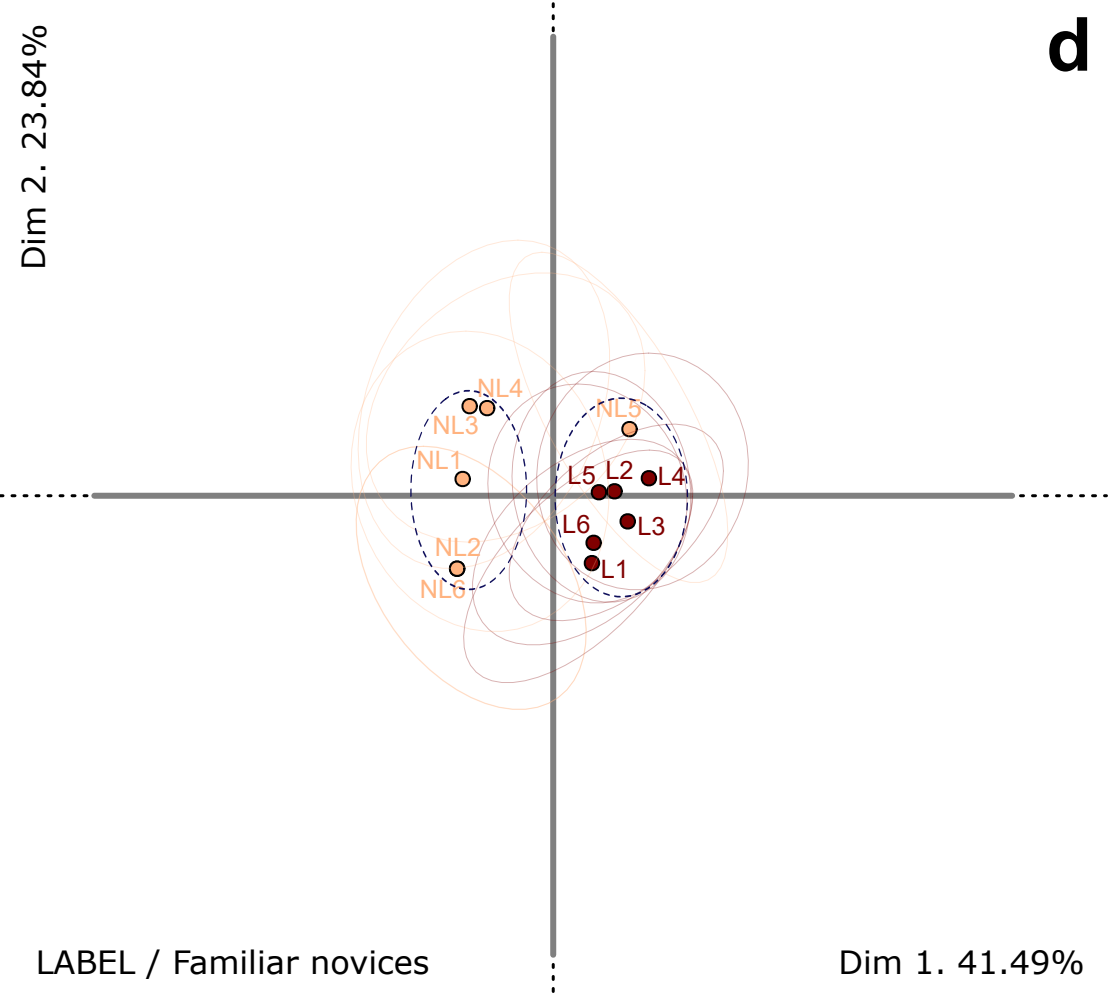


WINE / Familiar novices

Dim 1. 23.05%

d

Dim 2. 23.84%

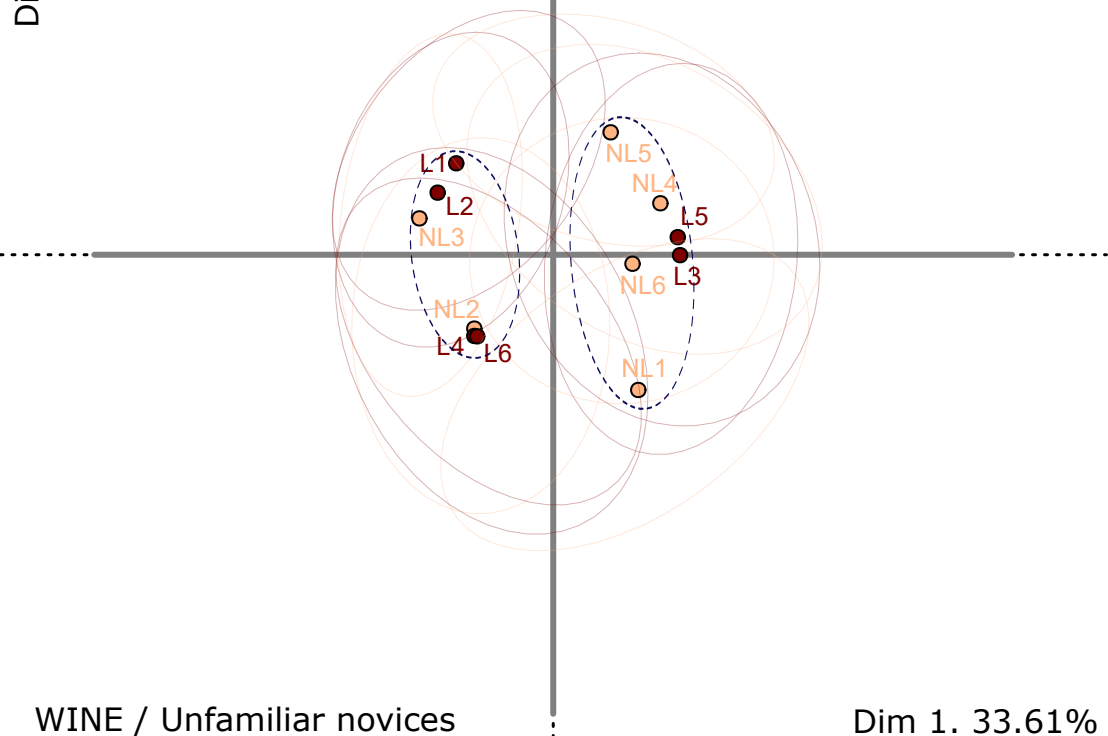


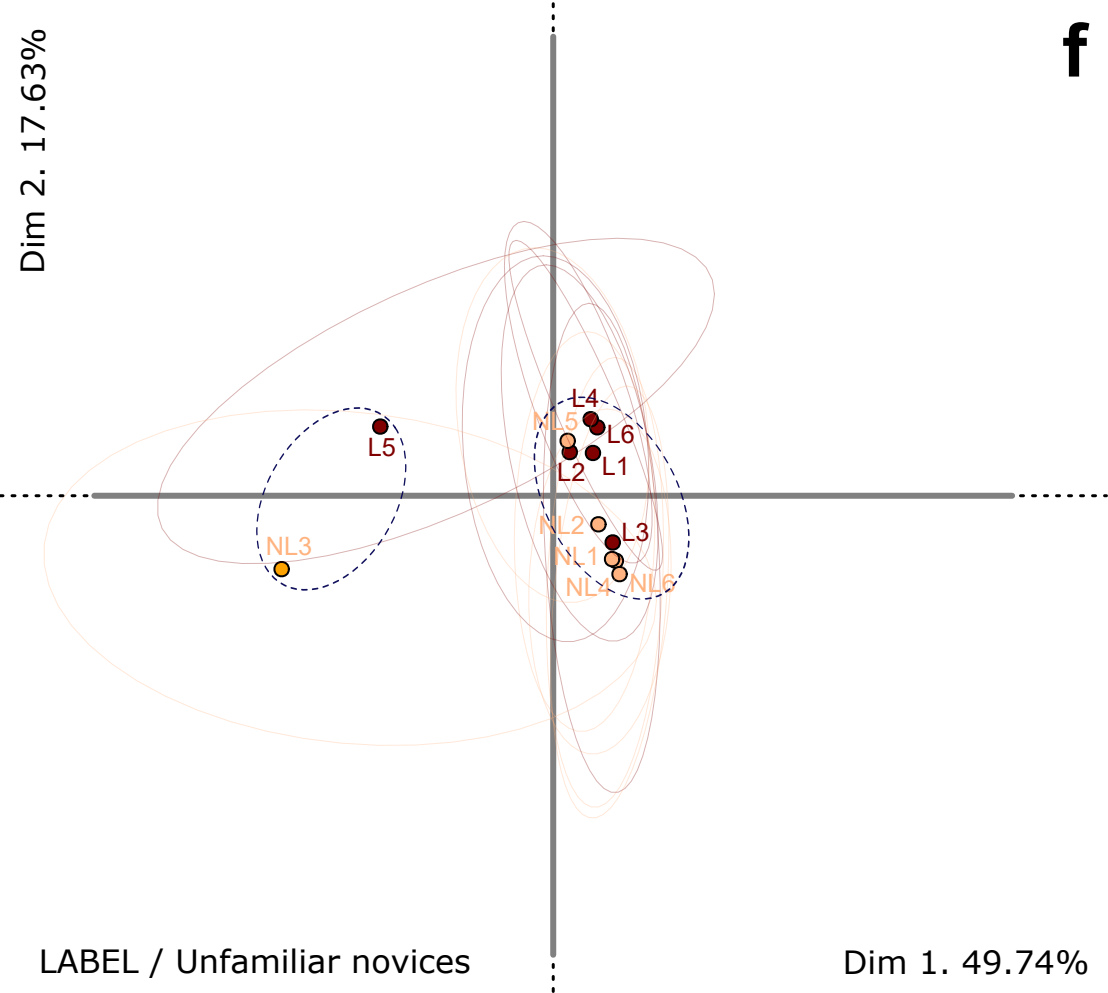
LABEL / Familiar novices

Dim 1. 41.49%

e

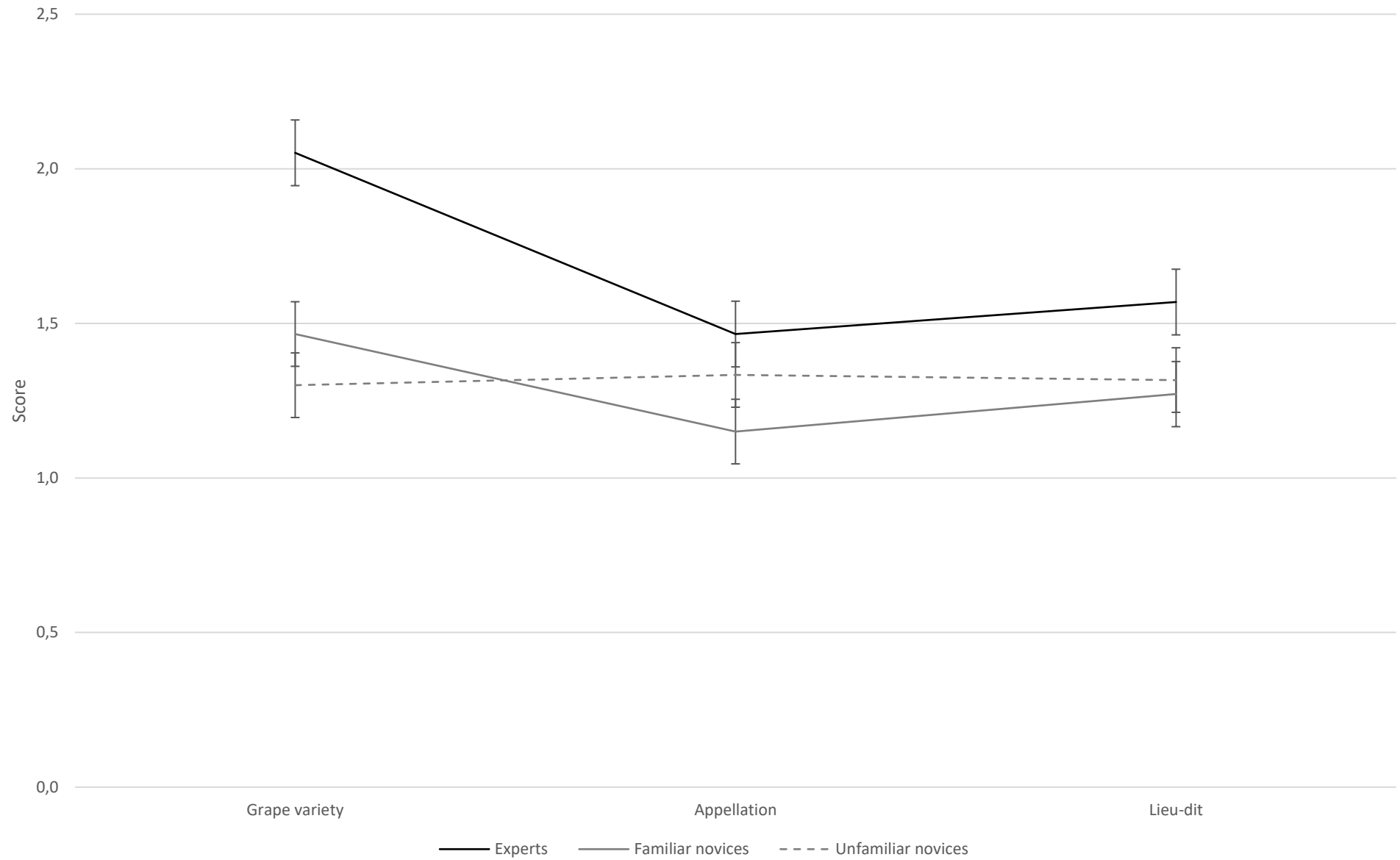
Dim 2. 19.39%





WINE: Expertise*level

a



LABEL: Expertise*level

b

