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## Evaluation of French and New Zealand Sauvignon wines by experienced French wine assessors

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### ABSTRACT

Certain odours are commonly associated with the bouquet of Sauvignon blanc wine. These characteristic varietal odours can vary to reflect origin of a Sauvignon blanc wine. In the present study, Sauvignon blanc wines from sub-regions of Marlborough, New Zealand, and from north France (Sancerre, Loire, and Saint Bris) were investigated in terms of (i) distinctiveness of country of origin, (ii) odour profile, and (iii) the concept of typicality (Ballester, J., Dacremont, C., Le Fur, Y., & Etievant, P. (2005). The role of olfaction in the elaboration and use of the Chardonnay wine concept. *Food Quality and Preference*, 16, 351–359). Twenty-three experienced French wine tasters (12 Oenology students and 11 Flavour Panellists), with no prior experience of Marlborough Sauvignon blanc wine, evaluated six French and six Marlborough Sauvignon blanc wines by ortho-nasal olfaction. A range of tasks was employed including descriptive profiling and sorting into categories based on origin of wine. The data were subjected to multivariate analyses. Principal components analysis of descriptive data showed that (i) wines were separable by country of origin (NZ or France), and (ii) clear sub-regional differences in perceived odour profile were reported for French wines, and to a lesser degree for New Zealand wines. Overall, New Zealand wines were evaluated as showing higher levels of both fruity (e.g., passionfruit) and fresh green notes (e.g., green capsicum), while French wines were judged higher on dried herbaceous characters and mineral/flinty notes. Contrary to expectation, the French participants rated New Zealand wines higher on the concept of typicality and higher on appreciation than the French wines. The results are discussed in terms of cognitive processing relevant to conceptualisation of wine typicality.

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### 1. Introduction

In much of Europe including France, a wine's distinctiveness and quality classification are defined by geographical designation of the specific grape variety. The basis for this is general acceptance that various climatic, viticultural and oenological factors can influence grape and wine composition (e.g., Clarke, 2001; Marais, 2001). New Zealand, a relatively new wine-growing region, is currently in the process of introducing geographic boundaries for its wine regions and sub-regions. In New Zealand, the wine most frequently reported as linked with a specific geographical designation and a distinctive varietal definition is Marlborough Sauvignon blanc.

Sauvignon blanc, *Vitis Vinifera* L. var. Sauvignon blanc, sometimes considered a "simple" or "non-floral" white grape variety (Masneuf-Pomarede, Mansour, Murat, Tominaga, & Dubourdieu,

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2006), none-the-less is often described as producing highly distinctive and characteristic wine in terms of varietal aroma (Marais & Swart, 1999; Tominaga, Furrer, Henry, & Dubourdieu, 1998). Sauvignon blanc is reported as originating in the Gironde area of South-west France during the seventeenth Century where it was known under several names (MacNeil, 2001). Today, Sauvignon blanc is a traditional cultivar of Bordeaux and Val de Loire (Darriet, Tominaga, Lavigne, Boidron, & Dubourdieu, 1995). The wines from the French areas of Sancerre and nearby Pouilly-sur-Loire have historically been considered France's classic examples (Schuster, 1989), while the Bordeaux Sauvignon blanc wines are much wider in range. Although Bordeaux does produce some of France's most illustrious examples of Sauvignon blanc wine, the majority are not single variety wines but are blended with Sémillon.

In newer grape-growing regions such as South Africa, Australia and New Zealand, Sauvignon blanc has become an important white cultivar (e.g., Marais, Hunter, & Haasbroek, 1999). Sauvignon blanc is currently the most planted white grape variety in New Zealand, and comprised 75% of all wine exports from New Zealand in the 2006–2007 year (NZ Winegrowers' Annual Report, June 2007).

The variety has a relatively short history in New Zealand, having been introduced to the North Island in the early 1970s. Subsequent plantings in the region known as Marlborough have produced internationally acclaimed wines that are characterised by a vibrant acidity balanced with specific fruit and vegetable characters (Parr, Green, White, & Sherlock, 2007).

The notion that wines from a specific geographical location can be sufficiently distinctive to be classifiable by sensory means underlies the present study. More specifically, we were interested in knowing how perception of typicality of Sauvignon blanc wines would be influenced by geographical origin of the wines. The concept of wine typicality has been employed to express when a particular wine represents well its category or concept (e.g., Ballester, Dacremont, Le Fur, & Etievant, 2005). Wine typicality may be based on varietal characteristics alone, particularly in wine producing regions where wines are labelled by varietal (e.g., Pinot noir), rather than by source or origin (e.g., red Burgundy). For example, a wine may be described as displaying a “typical Pinot noir nose”. Historically however, varietal characteristics are merely part of the story. Typicality has most often been applied when considering the characteristics of a food (e.g., cheese) or wine from a delimited geographical area, where expression of varietal characteristics and geographical origin are integrated. That is, key physical and cultural aspects of the delimited geographical area, often summed up by the word “terroir” (Jackson & Lombard, 1993), are together assumed to give a product typicality. Charters and Pettigrew (2007), in their discussion of wine quality, report that a wine considered to have typicality is a wine that reflects both its origin and varietal purity in a way that it forms a template against which other wines are measured. Arguably the wine that has received most attention of this nature, from both a chemical and sensory perspective, has been Chardonnay from Burgundy (e.g., Ballester, Patris, Symoneaux, & Valentin, 2008; Ballester et al., 2005; Moio, Schlich, & Etievant, 1994; Moio, Schlich, Issanchou, Etievant, & Feuillat, 1993).

The distinctive flavour profile associated with Sauvignon blanc wines from Marlborough, New Zealand, has also been central to recent investigations of wine typicality (e.g., Parr, Frost, White, & Marfell, 2004; Parr, Green, & White, 2006). This work has involved reporting data based on wine judgments undertaken by those experienced with the particular wine style (e.g., winemakers and wine judges in Marlborough) in keeping with Sauvageot's (1994) argument that extensive experience of the product of interest is required to adequately judge typicality. In a recent study, we demonstrated the ability of New Zealand wine professionals to clearly separate by sensory means Marlborough Sauvignon blanc wines with high typicality (i.e., those considered to be good examples of the wine style) from French Sauvignon blanc wines from Pouilly-sur-Loire and Saint Bris in northern France (Parr, Green, et al., 2007). These data, along with selected chemical analyses of the same wines (Parr, Sherlock, & Green, 2007), furthered our argument concerning the distinctive nature of Marlborough Sauvignon blanc wines.

The present study extended our prior work in three ways, and provided replication of key aspects. First, whereas prior studies have employed New Zealand wine professionals to evaluate Sauvignon blanc wines of both New Zealand and French origin, the current study employed participants with minimal experience of New Zealand Sauvignon wine. It was considered that this offered a more stringent test of what has been argued as “the distinctive flavour of Marlborough Sauvignon blanc” (Parr, Green, et al., 2007, p. 849). The participants in the present study were inexperienced with New Zealand wine but were experienced wine tasters, namely senior Oenology students and experienced wine flavour panellists in Burgundy. Second, we improved the design of our former study (Parr, Green, et al., 2007) by ensuring the French participants in

the current study evaluated an equal number of Sauvignon blanc wines of New Zealand and French origin. Third, the present study extended our work theoretically by providing data from a range of tasks performed by participants with no prior experience of one of the products of interest. Each wine was evaluated in terms of (i) aroma profiles, (ii) likely origin of the wine (a sorting task), (iii) the concept of typicality (i.e., in terms of what they considered to be a “good example of a Sauvignon blanc wine”), and (iv) wine appreciation (liking). These four tasks can reasonably be assumed to be weighted differently in terms of the cognitive processes implicated in their performance. The aroma-profiling task, where participants make analytical judgments about intensity of specific characteristics, is assumed weighted toward bottom-up cognitive processes, where responses emphasise phenomenological properties of the wine sample (Dalton, 2000; Parr, White, & Heatherbell, 2003; Parr, Green, et al., 2007). Conversely, the typicality rating, hedonic rating and sorting tasks are assumed to involve more global or holistic processing of the stimulus (wine sample), where variable contributions from top-down processes (i.e., higher-order cognitive processes that reflect a person's prior experience with wines) are implicated (Dalton, 2000; Parr et al., 2003). Hence, data from the four tasks should allow us to make theoretical conclusions about different aspects of cognitive processing of a novel stimulus (the New Zealand wines).

Previous results from our laboratories, along with anecdotal evidence, led us to hypothesise the following: (i) French and New Zealand wines would be discriminated as different; (ii) flavour profiles of the two wine groupings (i.e., French and New Zealand) would differ, with New Zealand wines expected to have higher ratings for primary varietal characters (e.g., passionfruit; green capsicum); and (iii) that French participants would rate French wines higher on typicality than they would rate New Zealand wines due to lack of experience with the latter.

## 2. Materials and methods

### 2.1. Participants

Twelve French Oenology students from Institut Universitaire de la Vigne et du Vin (IUVV), and 11 trained panellists from Centre des Sciences du Goût (CSG) in Burgundy, participated in the study. Age range of IUVV participants was 24–38 years, with a mean of 27 years. Age range of CSG participants was 24–68 years, with a mean of 37 years. The distribution of males and females was similar across groups (CSG: 3 Female, 8 Male; IUVV: 4 Female, 8 Male). The panellists of CSG were trained one hour per week to recognise aromatic references and to describe the odour properties of wine using a list of about 100 terms compiled from the literature (see Campo, Do, Ferreira, and Valentin (2008), for details). The wines used for the training included young and barrel aged red and white wines of diverse grape varieties and origins, and included experience of the three French wines included in the present study, namely Sauvignons from Sancerre, Loire, and Saint Bris. At the time of the present experiment, these panellists had already received 45 h of training and evaluation. The Oenology students also had prior experience of the French wines included in the study. On the other hand, not one participant had tasted New Zealand Sauvignon blanc wines prior to the study, although one Oenology student participant had knowledge of Cloudy Bay (Marlborough) Sauvignon blanc, including its frequently-described flavour profile.

### 2.2. Wines and materials

The wines comprised six commercial Marlborough New Zealand Sauvignon blanc wines from the 2005 vintage, and six

commercial French wines from the 2004 vintage. The wines were selected by wine professionals who, subsequent to direct communication with several of the wine producers, judged them as representative of their established wine styles and vintages. We selected French wines that were six months' older than the New Zealand wines to retain a consistency with other studies in our New Zealand laboratory (e.g., Parr, Green, Valentin, & Dacremont, 2008) and therefore avoid introducing a confounding factor. The New Zealand wines were all from the region known as Marlborough, but Marlborough is diverse in terms of soil types and climate (Rae & Tozer, 1990) and is frequently considered in terms of sub-regions (Parr et al., 2004). The six Marlborough wines were considered "terroir" wines (i.e., the grapes were grown in distinct locations): there were two wines from each of the three sub-regions reported in Parr et al. (2004), namely Rapaura (northern Wairau Valley), Brancott (southern Wairau Valley) and Awatere Valley. The French wines were from three, geographically-close sub-regions that produce 100% Sauvignon blanc wine. The sub-regions included the classic Sauvignon-producing areas of Sancerre and Pouilly-sur-Loire (see Table 1), along with the relatively recent Appellation of Saint Bris. A new bottle of each wine was opened for each session (see below for definition of a session). The wines were brought to ambient temperature, and were first checked for faults, in particular evidence of cork taint, by at least one experienced wine professional. Fifty-millilitre samples were then poured into standardised tasting glasses (ISO, 1977) that were opaque (black) to eliminate visual cues as sources of information. The glasses were coded with 3-digit numbers and were covered with plastic Petri dishes.

### 2.3. Procedures

The experimental design was a fully within-subject design. Each participant undertook all tasks, namely a typicality rating, an

aroma-profiling task, a hedonic (liking) rating, and a wine-sorting (classification) task, in that order.

Each participant underwent one specific training session prior to the experiment proper. This occurred one week prior to the experiment for the trained panellists, and on the same day as the experiment proper for the Oenology students. Training comprised two aspects. First, participants undertook a familiarisation exercise with the ten aroma descriptors to-be-employed in the experiment (see Table 2) by use of a range of reference standards to exemplify the particular sensory character. The 10 descriptors used in the specific, pre-experiment training were a sub-set of the 100 employed in the panellists' prior training sessions. A combination of chemical stimuli and fruits/vegetables (fresh and processed) were employed to exemplify the 10 to-be-rated aroma characteristics (see Table 2). Second, and subsequent to the familiarisation exercise, participants were asked to rate intensity of the 10 aroma descriptors used in the familiarisation task in each of three French Sauvignon blanc wines not employed in the experiment proper, one wine from each of Sancerre, Loire, and Saint Bris. The wines were served "blind" to participants in coded glasses. Individuals' results of the intensity rating exercise were collated and discussed with the group leader. Participants, already experienced with Sauvignon blanc wine, reported on average some differences amongst the three wines (e.g., Sancerre: fruity, high sulphur, and complex; Loire: ripe fruit/tropical and boxwood; Saint Bris: more herbaceous than the other wines), but these data were not tabulated and analysed beyond the training session.

In the experiment proper, participants evaluated the twelve wines by ortho-nasal olfaction in a single session. Participants were seated in separate booths, with the environment controlled as advised for sensory experimentation (ASTM, 1986). Five sessions were conducted across a week, with 3–9 people participating in any particular session. Flavour panellists and Oenology students were organised to participate in separate sessions. However, two

**Table 1**  
Sauvignon blanc wines employed in the experiment. NZ = New Zealand.

Wine	Country of origin	Region	Vintage	Ethanol (% v/v)	Bottle closure
Chatelain Pouilly-fumé Jean-Claude Chatelain	France	Loire	2004	12.5	Cork
Pouilly-fumé Les Vieilles Terres Dominique Pabiot	France	Loire	2004	12.5	Cork
Saint Bris Domaine Petitjean	France	St. Bris	2004	12.5	Cork
Jean-Marc Brocard Saint Bris Sauvignon	France	St. Bris	2004	12.5	Cork
Saint-Bris Domaine Anne Goisot Arnaud	France	St. Bris	2004	12.5	Cork
Sancerre Domaine du Carrou Dominique Roger	France	Sancerre	2004	12.5	Cork
Brancott Marlborough Letter Series	NZ	Marlborough: Brancott	2005	14.0	Screw cap
Framingham Marlborough	NZ	Marlborough: Rapaura	2005	13.5	Screw cap
Marlborough Awatere Starborough Creek	NZ	Marlborough: Awatere	2005	14.0	Screw cap
Triplebank Awatere Valley Marlborough	NZ	Marlborough: Awatere	2005	14.0	Screw cap
Marlborough Brancott Festival Block	NZ	Marlborough: Brancott	2005	14.5	Screw cap
Marlborough Rapaura Condors Forest	NZ	Marlborough: Rapaura	2005	14.0	Screw cap

**Table 2**  
Ten flavour descriptors employed in the study and reference materials used to exemplify odours commonly associated with each descriptor.

English	French	Reference materials
Mineral/smoky/flinty	Minéral/silex/pierre à fusil	Benzenemethanethiol (19 µg/L in 10% ethanol/water)
Leafy/stalky/vegetal	Végétal (e.g., feuille de tomate; asperge; haricot vert; petit pois en conserve)	Tomato stalk; fresh asparagus; canned peas; 2-methoxy-3-isopropylpyrazine (1200 µg/L in distilled water)
Grassy/fresh-cut grass	Herbe fraîchement coupée	Freshly-cut grass clippings
Herbaceous	Herbe sèche (foin; feuilles mortes; tabac)	Dried leaves; hay
Green capsicum	Poivron vert	Green capsicum slices; 2-methoxy-3-isobutylpyrazine (1200 µg/L in distilled water)
Grapefruit/citrus	Pamplemousse/zeste d'agrumes	3-Mercaptohexan-1-ol (906.7 ng/L in ethanol)
Boxwood/broom/sweaty/cat urine	Buis/bourgeon de cassis/pipi de chat	4-Mercapto-4-methylpentan-2-one (385.9 ng/L in ethanol)
Tropical	Fruits tropicaux (ananas; mangue; melon)	Fruits (banana; melon)
Stone-fruit	Pêche/nectarine/abricot	Firmenich aromas for peach, nectarine & apricot
Passionfruit	Fruit de la passion	Passionfruit pulp; 3-mercaptohexyl acetate (63.15 ng/L in ethanol)

flavour panellists attended the session with 7 Oenology students, but were positioned in booths in a separate part of the sensory evaluation room to minimise influence from the Oenology students. Wines were presented in a unique order for each participant, based on a William Latin-square arrangement generated by FIZZ software (Biosystèmes, Courtenon, France), to control for first-order carryover effects (i.e., the effect of wine  $N-1$  on wine  $N$ ). The same wine samples were used for the four aroma-evaluation tasks.

Participants were advised that they would be undertaking four ortho-nasal olfaction tasks, at their own pace, within their session. They were advised that all wines were Sauvignon blanc, but were not told the sources of origin of the wines until immediately prior to commencement of the fourth (final) task which was the sorting task.

First, participants rated blind the twelve wines on typicality. The instructions for rating typicality were adapted from [Ballester et al. \(2005\)](#), and were as follows:

“We ask you to imagine that you have to explain to a friend what a Sauvignon blanc wine is. For each wine presented, you must answer the following question: Do you think that this wine is a good example or a poor example of what a Sauvignon blanc wine is? Due to viticultural or oenological practices, it is possible that a Sauvignon blanc wine does not seem to you a good example of a wine from this variety. Our interest is in your own view.”

Typicality was rated via a 100 mm, horizontal visual analogue scale (VAS: see [Parr, Green, et al., 2007](#)) for each wine. The scale had the words “very good example” at the right-hand end and “very poor example” at the left-hand end.

The second task involved rating each wine on intensity of the ten specific aroma descriptors that had been employed during the earlier practice session. There were two orders of the ten descriptors; odd numbered participants rated the descriptors in a random order (Order 1), whilst even-numbered participants rated the ten descriptors in Order 2 (the reverse order of Order 1). The ten descriptors had been selected on the basis of their reported salience to Sauvignon blanc wine in our prior studies, and their importance from a chemical perspective (e.g., [Tominaga, Baltenweck-Guyot, Peyrot des Gachons, & Dubourdiou, 2000](#)). Aroma intensity was rated via five discreet categories displayed as five boxes in horizontal format for each aroma descriptor. A number from zero to four was above each box, with zero above the most left-hand box and four above the most right-hand box. To qualify the quantitative task, the following intensity rating instructions were given: 0 = absent; 1 = feeble/low; 2 = medium; 3 = strong; 4 = very strong.

Third, participants rated each wine in terms of how much they liked the wine via a 100 mm, horizontal VAS scale with “I like very much” on the right-hand end and “I do not like at all” on the left-hand end. Finally, a sorting task was performed. Participants were now told that not all the wines were French, and were asked to sort the 12 wines into two groups, namely those that were of French origin and those that were of New Zealand origin. Participants were asked to give a few words or descriptors that provided the criteria on which they had based their sorting (e.g., “very fruity”; “more complex nose”). Space on the data sheet was constrained to restrict to 4–5 maximum the number of descriptors reported by a person to each category.

#### 2.4. Data analysis

Ratings to 100 mm VAS scales for typicality and for liking were quantified in terms of a number between zero and 100. Intensity ratings to each of the ten flavour descriptors were quantified as a

number between zero and four. Complete data were collected for liking and all aroma descriptors, but two of 276 typicality data points were missing, and were imputed using SPSS 14.0 MVA Maximum Likelihood Estimation (expectation–maximisation algorithm). Results are presented for the imputed data, but the pattern of results for the original data are extremely similar to the imputed data.

Analysis of variance (ANOVA) was performed on aroma descriptor scores, typicality and appreciation, using a mixed model with participant as a random factor and country and region (nested in country) as fixed factors. Data from the sorting task for each of the twelve wines were converted into a similarity matrix by summing over all participants the number of times each pair of wines was sorted into the same group. This matrix was analysed with multidimensional scaling (MDS) implemented by the PROXSCAL procedure in SPSS 14.0, with a simple Euclidean model applied to ordinal data where ties were not kept tied. The matrix was then submitted to a between-groups linkage hierarchical cluster analysis (HCA) to identify groups, which were then plotted in the MDS space.

Principal components analysis (PCA) was undertaken with SPSS 14.0 FACTOR with varimax rotation, performed on product means averaged across participants. Similarity between MDS and PCA solutions was tested with the RV Coefficient ([Robert & Escoffier, 1976](#)), which is a multivariate generalisation of the correlation coefficient. The coefficient was computed in R 2.5 ([www.r-project.org](#)) following the formula in [Abdi \(2007\)](#). The RV Coefficient ranges between 0 and 1, with values closer to 1 indicating higher degrees of similarity. Good agreement has been reported with values from .68 ([Tang & Heymann, 2002](#)) upward.

### 3. Results

#### 3.1. Univariate analyses

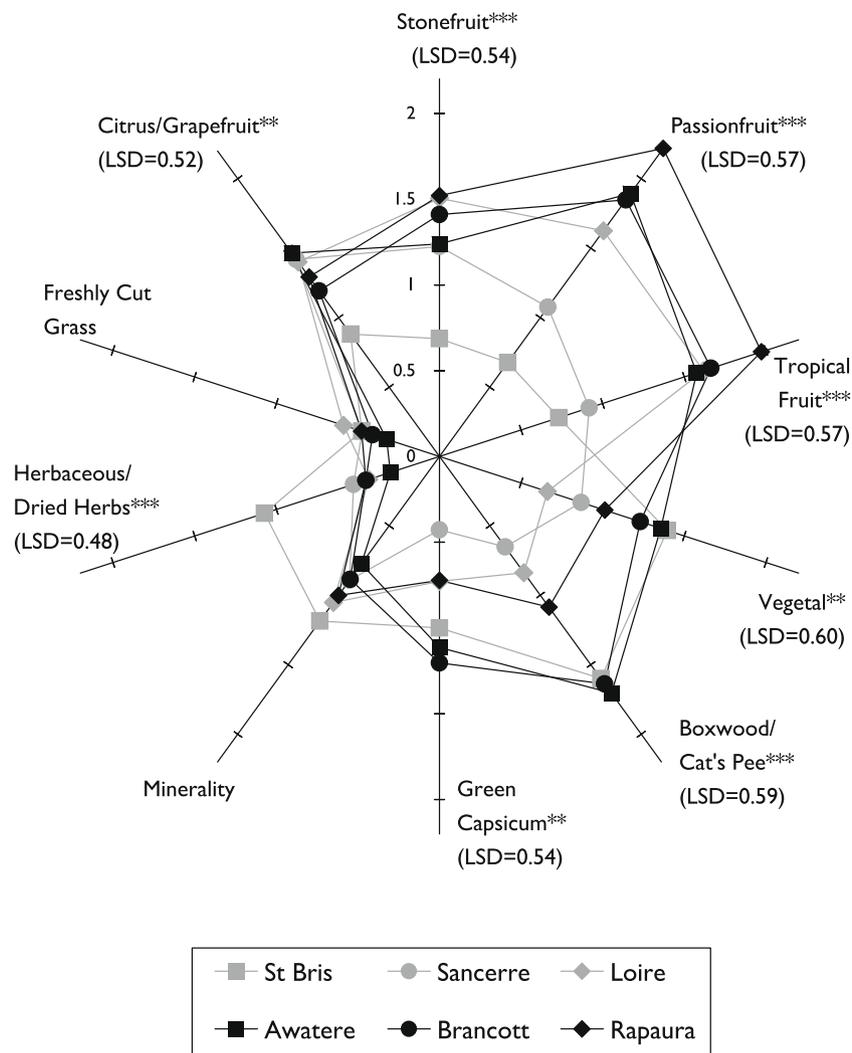
Participants' intensity ratings to the ten aroma descriptors for each wine produced aroma profiles that demonstrated differences as a function of country of origin ([Table 3](#)), with New Zealand Sauvignon blanc on average having stronger stone-fruit, passionfruit, tropical, boxwood and green capsicum characters, whereas the French Sauvignon blanc wines were perceived to have stronger herbaceous character. There was also a marginal trend, suggesting a slightly higher vegetal/stalky character to New Zealand wines. These aroma-profile results for French and New Zealand wines judged by French participants are similar to flavour-profile data reported in [Parr, Green, et al. \(2007\)](#) where the wines were judged by New Zealand participants.

Aroma profiles were also found for sub-regions (France: Saint Bris, Loire, & Sancerre; New Zealand: Awatere, Brancott, & Rapaura) as depicted in [Fig. 1](#). Rapaura Sauvignons (northern Wairau Valley in Marlborough, New Zealand) stood out in terms of higher levels of passionfruit and tropical fruit notes. Wines from Awatere and Brancott showed very similar flavour profiles and were perceived as more “green” and less “ripe” than wines from Rapaura. The wines from Saint Bris (Burgundy, France) were distinctive in their perceived herbaceous characters, and low intensity of ripe characters, such as passionfruit and stone-fruit. In contrast, wines from the Loire showed a more similar but somewhat less “green” profile to the New Zealand wines. Finally, the wine from Sancerre was characterised by lower intensity ratings, with the exception of more pronounced citrus notes.

Contrary to our prediction, New Zealand wines were rated higher both in terms of typicality and appreciation ([Table 3](#)). However, while New Zealand wines were judged by ortho-nasal olfaction to be overall better examples of Sauvignon blanc than the

**Table 3**Mixed model ANOVA, with *F*-ratios, error mean square, and mean ratings by country for aroma descriptors, typicality, and liking of wine (appreciation).

	Country		<i>F</i> (1, 248)		Region(Country)		MSE
	France	New Zealand			<i>F</i> (4, 248)		
Stone-fruit	1.05	1.39	4.68	*	6.00	***	0.86
Citrus/grapefruit	1.15	1.33	.54		3.75	**	0.79
Passionfruit	1.07	2.01	48.66	***	7.34	***	0.98
Tropical	1.06	1.75	27.86	***	6.53	***	0.97
Boxwood	1.20	1.49	12.55	***	8.34	***	1.03
Minerality	1.10	.90	2.20		0.98		0.70
Fresh cut grass	.51	.41	1.74		0.53		0.42
Green capsicum	.83	1.03	6.43		3.54	**	0.87
Vegetal/stalky	1.07	1.21	3.05	<sup>1</sup>	4.47	**	1.05
Herbaceous	.77	.41	6.84	**	5.12	***	.67
Typicality	40.4	60.1	37.76	***	4.09	**	519.52
Appreciation	39.1	56.1	24.15	***	10.47	***	447.55

\*  $p < .05$ .\*\*  $p < .01$ .\*\*\*  $p < .001$ .<sup>1</sup>  $p = .082$ .**Fig. 1.** Aroma profiles of wines as a function of country of origin (France or New Zealand) and sub-region (France: Saint Bris, Sancerre, Loire; New Zealand: Awatere, Brancott, Rapaura). Sub-region means that differ by more than the LSD value for that descriptor differ in a Fisher's LSD multiple comparison test.

French wines in the study, the boundaries between these two geographical origins were not well defined. Fig. 2 shows wines placed along a perceived typicality gradient from the least to the most

typical example of a Sauvignon wine. Within this gradient, French wines were organised along sub-regional origin, but not New Zealand wines. A similar pattern is shown for liking. The relationship

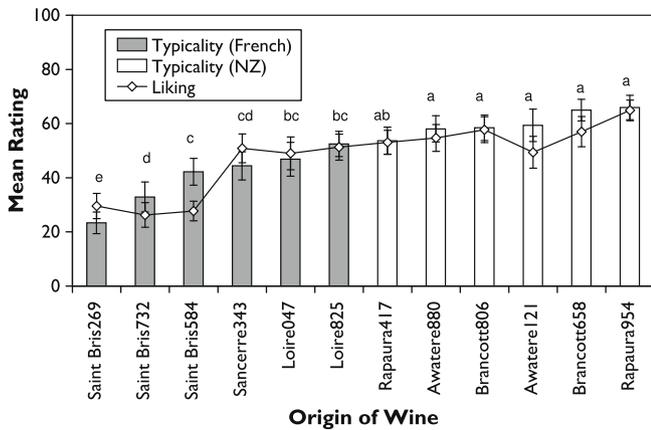


Fig. 2. Mean typicality and liking scores for each wine. The letters represent the results of Fisher's LSD paired comparison tests for typicality.

between mean liking and mean typicality depicted in the graph was representative of the pattern for individual participants, with the correlation between each participant's typicality and liking ratings averaging .62 ( $SD = .31$ ), and the correlation for 18 of the 23 participants exceeding .50. The significantly higher mean typicality and liking ratings given to New Zealand wines than to French wines appear to have their sources in the low ratings given to wines from Saint Bris. As can be seen from the letters denoting Fisher's LSD post hoc tests in Fig. 2, typicality ratings for the Loire and Sancerre wines were not clearly different to the New Zealand wines, but were different to the lowest-rated Saint Bris wines.

3.2. Multivariate analyses

Sauvignon blanc wines from New Zealand were in general discriminable from Sauvignon blanc wines from France, as is evident from the MDS space plotted in Fig. 3. Within the French wines, a clear discrimination was made between wines from Saint Bris (lo-

cated toward the right) and those from Loire and Sancerre, the latter grouping together at the top of the plot. The New Zealand wines did not separate as a function of sub-region in this analysis. The data in Table 4 provide an indication as to the basis on which the wines separated. Wines located to the right on Dimension 1 (Saint Bris) were associated with higher perceived levels of herbaceous/dried herbs characters, whereas wines further to the left showed higher levels of stone-fruit, citrus/grapefruit, passionfruit and tropical fruit characters. Wines located higher on Dimension 2 (Val de Loire and Sancerre) trended toward higher grassy/fresh herbs notes. The New Zealand wines, located lower on Dimension 2, exhibited more intense boxwood/cat urine, green capsicum, and vegetal characters. This pattern is similar to that evident in the Spider Plot in Fig. 1. Table 4 also shows that Dimension 1 of the MDS output had a strong relationship with both typicality and liking, with wines located further to the left being rated higher on both.

The distinctive character of the Saint Bris wines relative to both the other French wines and to the New Zealand wines was further demonstrated in that 13 of 23 participants placed all three Saint Bris wines in the same category in the sorting task. Discrimination overall however was not highly accurate in terms of identification of country of origin of each wine, with many participants labelling French wines as New Zealand and vice versa. For example, one participant accurately grouped all the French wines together but labelled them as New Zealand, and grouped all the New Zealand wines together but labelled them as French. While it appears that the New Zealand and French wines could be considered "confusable" on the basis of the sorting task data, apart from the highly discriminable Saint Bris wines, this may be due to participants sorting the wines into two groups only, as instructed by the experimenters.

More complex relationships within aroma profiles, as assessed by PCA (Fig. 4), show similar groupings to the MDS solution, demonstrating again a clear discrimination between French wines from Saint Bris and the other French wines. The apparent similarity in the solutions returned an RV Coefficient of .73 indicating good agreement. Wines from Saint Bris opposed the New Zealand wines on Component 1, whereas the other French wines were separated from the New Zealand wines on Component 2. The New Zealand end of the Component 1 spectrum was characterised by ripe flavours (passionfruit, tropical, citrus, stone-fruit), with the Saint Bris end loading highly on herbaceous and mineral.

Component 2, which differentiated French wines from Sancerre and Loire from New Zealand wines, shows the former wines to be characterised by a relative absence of boxwood, green capsicum, and vegetal notes, but high on fresh-cut grassy notes. It is interesting that in the present study, fresh grassy notes were not associated with other "green" characters as has tended to be the case

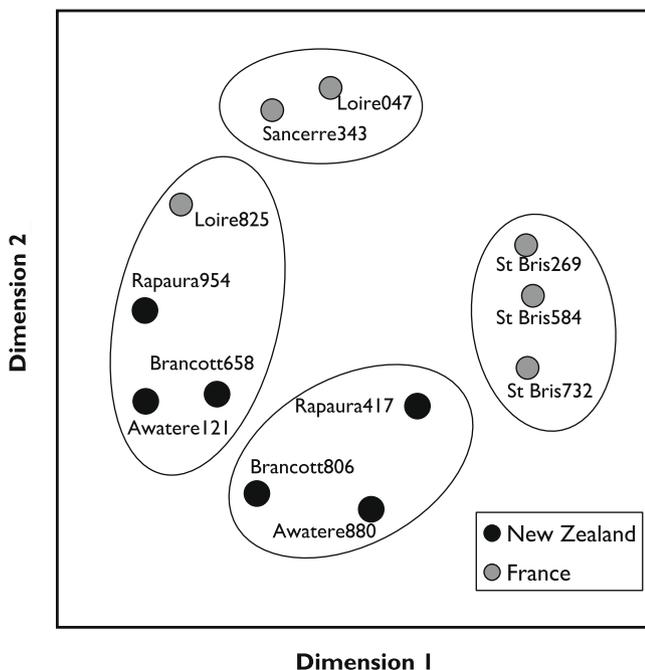
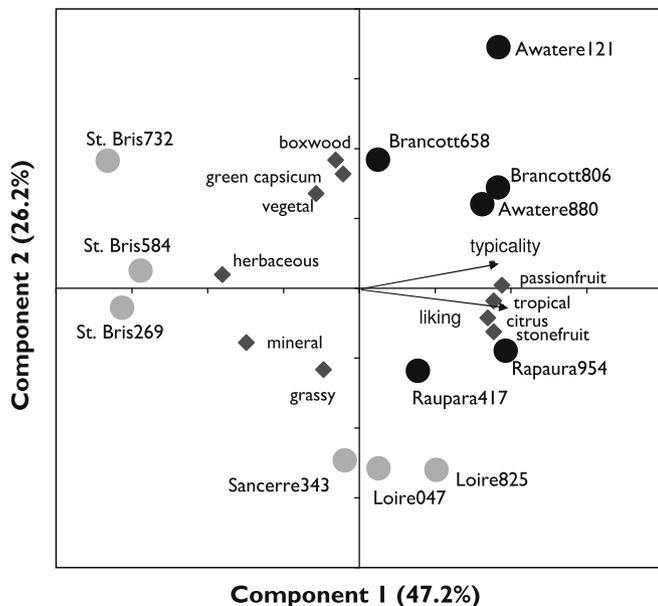


Fig. 3. Wines represented in multidimensional space from the sorting task. Wines contained in an ellipse were grouped together by cluster analysis.

Table 4  
Correlations between MDS dimensions and mean descriptor ratings.

	Dimension 1, r(12)	Dimension 2, r(12)
Stone-fruit	-.71**	-.04
Citrus/Grapefruit	-.66*	.02
Passionfruit	-.72**	-.41
Tropical fruit	-.71*	-.29
Boxwood/cat urine	.29	-.70*
Minerality	.61*	.45
Fresh cut grass	.16	.50
Green capsicum	.19	-.67*
Vegetal	.52 (p = .085)	-.67*
Herbaceous/dried herbs	.87**	-.13
Typicality	-.78**	-.42
Liking	-.89**	-.16

\* p < .05.  
\*\* p < .01.



**Fig. 4.** Principal components analysis descriptor loadings (diamonds) on Component 1 and Component 2 with scores plotted for each wine. Vectors represent correlation with Component 1 and 2 scores with mean typicality and liking (appreciation).

in our prior studies where predominantly New Zealand wines were evaluated by New Zealand participants (e.g., Parr, Green, et al., 2007). Overall, the PCA shows greater regional differentiation within the six New Zealand wines than the MDS, with the two wines from the warmer site in Marlborough (Rapaura) clustering closer to the Sancerre/Loire wines, whilst the Awatere and Brancott wines were associated with more “green” notes and less fruity notes.

### 3.3. Qualitative data

An attempt was made to classify the self-reported descriptors that had been produced by participants to explain the criteria they used as a basis for sorting the 12 wines by wine origin. Not all participants provided aroma descriptors. The first major result was that no descriptors were given by any participant to wines they categorised as “New Zealand”. For wines they categorised as “French”, descriptors synonymous with “ripe”, “tropical” and “fruity” provided the major criterion used to classify French wines accurately as French. On the other hand, New Zealand wines that were classified as “French” were done so on the basis of perception of complexity, along with specific green and fruity notes.

## 4. Discussion

The present study evaluated the impact of geographical origin on Sauvignon blanc wine aroma properties. To address this issue, we asked participants to make both global (sorting task, typicality-rating task, and hedonic task) and analytical (descriptive task) judgments to a sample of Sauvignon wines (100% Sauvignon blanc) from each of France and New Zealand. Global judgments reflect both the sensory properties of the wines and the participant’s prior knowledge about the wines whereas analytical judgments reflect mostly sensory properties of the wines (Parr, Green, et al., 2007).

The major result of the sorting and typicality-rating task was demonstration that French participants were able to separate Sauvignon blanc wines on the basis of olfactory-driven perceived aroma, not only by country of origin, but also in terms of regional

differences within France. This result confirms the idea that different geographical origins appear capable of producing wines with highly distinctive aroma characteristics. In particular, French Sauvignon wines from Saint Bris have been clearly separated from the other wines in the sorting task, and evaluated as less typical of a Sauvignon wine than New Zealand wines and to a lesser extent, French Sauvignon wines from Loire.

With respect to aroma profiles, the selected wines from Saint Bris were described as more herbaceous and mineral and less ripe than the Loire and New Zealand wines. The French Sauvignon wines from Loire were perceived as closer to the New Zealand Sauvignon wines in aroma profile, but somewhat different from them. Their typicality scores were in between those of French Sauvignon wines from Saint Bris and New Zealand Sauvignon wines. Compared to New Zealand wines, the Loire wines in the present study were described as having less intense fruity, boxwood, green capsicum, and vegetal notes, but higher fresh-cut grassy notes. Our data are not too dissimilar to wine writers’ descriptions of French Sauvignons from the respective sub-regions, currently found on producers’ web pages. The reviews suggest that wines from Sancerre and the Loire have sensory profiles of grassy, nettles, and gooseberry notes, with high acidity. Differences include that Sancerre wines are reported as being more “pungent”, while Loire wines have a “smoky” mineral note that is considered to have its source in the particular limestone where the grapes are grown. Sauvignon blanc wines from Saint Bris, grown on soils similar to Chablis wines, are reported by several producers (e.g., William Fevre) as “scintillating, steely, and taut”, with herbaceous, grassy, and cat urine notes.

No such clear sub-regional distinction was observed in the sorting and typicality tasks for New Zealand Sauvignon wines. This lack of sub-regional distinction among New Zealand Sauvignon wines, assessed by global evaluation tasks, is somewhat surprising with regards to our previous work. For example, when New Zealand wine professionals evaluated New Zealand wines from the same producers and regions but of an earlier vintage (Parr et al., 2004), wines from Rapaura were rated as riper/fruiter, and discriminable from Awatere and Brancott wines, the latter having “greener” profiles. It is conceivable that the different results reflect vintage differences (2005 Marlborough wines in the current study, and 2003 wines in Parr et al. (2004)) or methodological differences between the studies. In the current study, wine evaluation was entirely by ortho-nasal olfaction, whereas Parr et al. (2004) reported both ortho-nasal and tasting data. This would seem unlikely however, in that Parr et al. (2004) reported Rapaura wine to be discriminable from both Awatere and Brancott Sauvignon blanc wine by olfaction alone.

A more cognitive analysis is that this result might be due to the fact that participants in the present study had no prior knowledge of New Zealand Sauvignon wines, and therefore no internal references regarding Marlborough wines and their sub-regional differences. As mentioned previously, both the sorting and the typicality task depend in part upon participants’ previous knowledge with wines. Specifically, French participants might have developed an internalised standard of Sauvignon blanc (or sensory concept) that is well adapted to distinguish among French wines but not among New Zealand wines. From a theoretical point of view this result can be explained in terms of perceptual learning. This notion, first proposed by Gibson (1969), refers to “an increase in the ability to extract information from the environment, as a result of experience and practice with stimulation coming from it” (p. 3). According to Gibson’s view, the perceptual system becomes attuned to its environment and so learns to select and encode the features that are useful to discriminate within a set of stimuli. These features constitute an optimal representation of the set of stimuli from which they have been extracted, but are not efficient

to distinguish between other stimuli. A classical example of perceptual learning is what is called the “other race effect” (people are better at recognising faces of their own “race” than faces from other “races”) in the face recognition literature (O’Toole, Abdi, Defenbacher, & Valentin, 1995).

These sensory features however might not be adapted to distinguish among the New Zealand wines employed in the current study. In agreement with this interpretation, results from the aroma descriptive-rating task, an analytical task assumed less influenced by prior knowledge with the wines, showed some sub-regional separation among New Zealand Sauvignon wines. In particular, the two wines from Rapaura tended to be perceived as having more fruity notes and less green notes than New Zealand wines from the two other regions, a result supported by our prior work.

Another interesting aspect of our data is that although French participants were able to distinguish the French Sauvignon blanc wines from the New Zealand ones, they frequently misidentified them. Indeed, they often classified the French wines as New Zealand wines and conversely, New Zealand wines as French. Also, contrary to our hypothesis, they judged the New Zealand wines as being better examples of Sauvignon wines than the French Sauvignon wines employed in this particular stimulus set. How can we explain this result? French participants did not have prior exposure to New Zealand Sauvignon wines, so a cognitive analysis would assume that their internal standard should correspond to French Sauvignon wines.

Previous work (Parr, Green, et al., 2007; Ballester et al., 2005, 2008; Hughson, 2003; Brochet & Dubourdieu, 2001) has expressed in various ways the hypothesis that, through repeated exposure to wines made from different grape varieties, people with wine expertise develop some kind of prototypes (mental constructs) that then represent the sensory signature (or typicality) of these wines. Further classification or typicality judgments would then be made with reference to these prototypes. According to Parr, Green, et al. (2007, p. 851), “habitual exposure to a product is assumed to refine judgments of central tendency (the ‘ideal’ or ‘typical’ example), as well as adjust concept boundaries”. Following this view, French participants’ prototypical representation of Sauvignon blanc wines should reflect the sensory properties that they have more often encountered in French Sauvignon blanc wines. Yet, the New Zealand wines in this study were judged more typical than the French wines. A first plausible explanation is that the French wines used in this study were not representative of French Sauvignon blanc wines and thus are far from the French prototype of Sauvignon blanc wines. This could be the case for Saint Bris wines, which are not well known in France, but is less plausible for Loire wines that have been argued as classic examples of French Sauvignons (Schuster, 1989). Further, as reported above, wine reviews of current vintages of Saint Bris and Loire wines found on the internet sites of wine producers do not differ greatly in flavour spectrum from our current sensory data.

Another conceivable explanation is that participants might not have used a prototype of French Sauvignon blanc (i.e., central tendency, based on actual experience) as reference to perform the task but rather a “caricature” of Sauvignon blanc, rich in exotic fruit notes, green and boxwood notes, as described in many wine reviews, especially reviews of Marlborough Sauvignon blanc wines by international wine critics. Caricatures can be considered extreme prototypes (Ameel & Storms, 2006). New Zealand wines, richer in these notes, would then be judged more typical of Sauvignon wines than Saint Bris wines, the latter richer in mineral and herbaceous notes.

A third explanation that cannot be ruled out is that participants based their classification and typicality judgments on hedonic values and (i) judged the wines they liked best as more typical and (ii)

identified them as French. Such a relation between hedonic value and wine typicality was previously reported in Ballester et al. (2008). Yet, as noted by Ballester et al., it is difficult to know if a wine is liked because it fits our prototype (be it central tendency or caricature) or if it is judged typical because we liked it. This third explanation however cannot be the whole answer, since the correlation reported in the present study between typicality and liking was only 0.62. As well, oenology students and trained flavour panellists will have been “trained” to distinguish between judging typicality and making hedonic judgements such as liking and preference. None-the-less, the novelty of the situation for the French participants, who had not experienced New Zealand Sauvignons before, may have caused either a “caricature” or an hedonic judgment to dominate and over-ride a typicality assessment based on prior sensory experience. In short, the present study cannot clearly identify the exact underlying cause of this unexpected result.

In summary, the present study has demonstrated distinctive flavour profiles associated with a selection of Sauvignon blanc wines from each of France and New Zealand, as judged by French participants. In doing so, the current study extends, and to a large degree replicates our prior work. A qualification of the present work is that the stimulus set, comprising six New Zealand and six French wines only, was relatively small, albeit carefully selected as representative of wines from each of the respective regions. Further, the results cannot be generalised beyond situations where the French Sauvignons evaluated were six months older than the southern hemisphere wines from New Zealand. In other words, it is conceivable that were the French wines younger than the New Zealand wines, different results may have been obtained. An aspect of the study that clearly requires further work is investigation of the concept of typicality in relation to chemosensory stimuli when novel stimuli (i.e., wines never encountered before) are included in the stimulus set. Research concerning visual stimuli, specifically those employed to study face recognition and “ideal” category members, has shown that a face never actually seen before can be judged “ideal” or prototypical if it contains many desirable elements of previously-seen faces (Reed, 1972). Future work in our laboratories is en train to follow up this idea.

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