Rebranding wine using sensory profiling data: A case study

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Since the 1990s, the consumer goods industry and the food and beverage industry in particular have increasingly incorporated consumer science to ensure and improve business and product performance (Moskowitz et al., 2012). Consumer science takes many forms—consumer tastings, focus groups, interviews, and surveys, among others—that provide insight into consumer behavior and perception, which in turn informs market preferences and captures trends in consumption and taste.

This sensory study focuses on wines from British Columbia's Okanagan Valley and the US Columbia Valley regions. BC in particular has seen a rapid rise in locally produced wine that has led to a concomitant increase in wine purchases. This is so much the case that the locally produced BC wine purchases are a recognized trend in Canada's consumer goods industry. The BC wine industry is said to have matured after the first Okanagan's subappellation (Golden Mile Bench) was approved. Consequently, there is growing interest among industry stakeholders to market wines from specific geographic locations within BC to showcase the region's "terroirs" (Shore, 2015). Wine purchases in British Columbia reached Can$1 billion for the first time in 2014. Data from the British Columbia Liquor Distribution Branch (BCLDB) confirmed this trend with wine sales for 2014 increasing 5.68% to a total of 68.9 million liters (Korstrom, 2015). The BC Vintners Quality Alliance (VQA) appellation remains the second-best-selling category in BC, representing a market of approximately 17% of sales in liters (British Columbia Wine Institute, n.d.). This fast-growing category is ahead of wine imports and behind British Columbia non-VQA wines among which is included the "Bottled in British Columbia—From International and Domestic Wine" category. According to the same source, the average price for a bottle of VQA wine was Can$17.69 in 2015.

To investigate the elements of a developing taste culture unique to the region's artisanal wines, we organized two sensory evaluations of nine merlot wines from the Okanagan Valley (Canada) and one from the Columbia Valley (the United States). The commercial wines were chosen based on their availability locally and reflected multiple vintages. They came from distinct grape-growing areas within the Okanagan Valley and the Columbia Valley (see Figs. 9.1 and 9.2), with each region representing a "terroir."

Widely used in wine research for sensory profiling, quantitative descriptive analysis is a sensory method that decodes the likes and dislikes of consumers (Lawless and Heymann, 2010) and requires a panel of trained tasters to objectively

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Fig. 9.1 Map of the Okanagan Valley.
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rate the sensory characteristics of a food product. In our study, six local wine professionals with recognized credentials in the industry assessed the 10 wines. This type of experiment uses precise wine descriptors that have meaning for the winemaker. These descriptors inform consumer preferences on a particular region or market niche and can be fundamental in educating other consumers on the organoleptic profiles of wines.

In this chapter, the authors present a case study where 10 wines of designated appellation are sensorially assessed using a widely accepted scientific methodology. The tasting methodology is presented followed by experimental results. The reader should refer to the bibliography for an overview of the sensory analysis field and how it is applied to the sensory evaluation of wine. The last section offers expert insights and its implications for the BC wine producer.

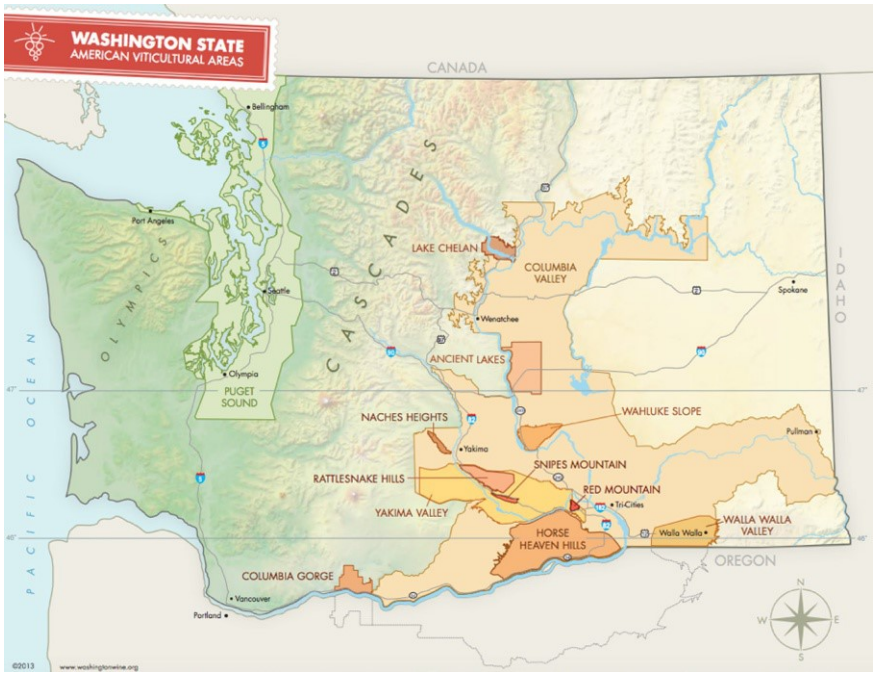

Fig. 9.2 Map of the Columbia Valley.
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9.1 Methodology

9.1.1 Wines

The 10 merlot wines sampled for this study are detailed in Table 9.1. The decision to include one American wine among the nine Canadian wines was based on the assumption that a merlot produced in a geographic region located south of the Okanagan Valley may display a different sensory character. Wines were selected based on availability and were from different vintages. For confidentiality reasons, only wine region and no winery names are mentioned in Table 9.1. For each wine, two bottles were purchased to be used in one of the two implemented tastings.

9.1.2 Methods

The six panelists recruited for the study held an enology degree at minimum or a Wine & Spirit Education Trust (WSET) level 3 diploma and were professionally active in the local and international wine industry. All had prior experience rating wines using attribute scales. The panelists evaluated each wine for seven aroma descriptors and eight taste and flavor descriptors, following a descriptive analysis methodology adapted from Guinard (2006). We used a predefined list of red wine sensory attributes

Table 9.1 Wines' details

Wine no.	Vintage	Region	Alc (%)	Price (CAD)
1	2013	Okanagan Valley—Golden Mile	13.8	$18.95
2	2013	Okanagan Valley—Naramata Bench	14	$19
3	2013	Okanagan Valley—Oliver	14	$17.50
4	2011	Okanagan Valley—Skaha Lake	14.2	$35
5	2014	Okanagan Valley—Golden Mile	13.9	$14
6	2012	Okanagan Valley—Center	14.2	$17.39
7	2012	Columbia Valley—the United States	13.5	US$17
8	2012	Okanagan Valley—Naramata Bench	14.5	$20
9	2013	Okanagan Valley—Golden Mile	14	$17.49
10	2013	Okanagan Valley—Oliver + Osoyoos	14	$15.99

that were well understood by all tasters. The panel received no training on the sensory attributes prior to the evaluations.

The panel also assessed the overall quality of the 10 wines using a quality assessment grid based on a 20-point scoring sheet adapted from the University of California at Davis in 1959 (Noble, 1995). Because the evaluations were conducted blind, assessments were based solely on sensory perceptions, free of brand bias or any previous experience with specific varietals.

The panel assessed each wine twice. Tastings took place on 2 different days approximately 2 weeks apart for three of the panelists; the other three panelists, due to time restrictions, completed both tastings on the same day. In both cases, the wines were coded with unique three-digit codes and presented in ISO glasses to the panelists who knew only that they were tasting red wine. The sequence in which each participant tasted the wines was randomized to avoid any contrast effects that may impact sensory perception.

Rather than using a monadic sequence, we followed Lawless and Heymann (2010) and served all wines at once. We chose this procedure because all samples were similar in size and appearance and thus could be evaluated in one tasting session. The wines were served at room temperature, approximately 30 min before the tastings took place, and glasses were covered with petri dishes immediately after pouring. Samples were first evaluated by orthonasal olfaction, then tasted, and finally expectorated. Judges were given water and salt crackers to rinse their palates between samples. Both tastings took place in the BC Wine Sensory Lab at Okanagan College in Penticton.

The panelists assessed the wines using the formats included in Appendix 1 (10 cm linear scales for wine aroma and taste/flavor descriptors) and Appendix 2 (quality

assessment based on the adapted UC Davis 20-point scale). As shown in the format, the descriptive analysis included the following attributes: "vegetative" (aroma), "vegetal" (aroma), "berry" (aroma), "green bell pepper" (aroma), "cassis" (aroma), "spicy aroma," "oak aroma," "berry flavor," "oak flavor," "bitterness," "astringency," "acidity," "mouthfeel," "length of finish," and "balance." For quality assessment, participants were asked to rank the wines according to appearance and color, aroma, defects and faults, residual sugar (bitterness/acidity), body and mouthfeel, flavor length of finish and balance, astringency, and overall quality. Each attribute was scored resulting in a total overall quality score out of 20.

9.1.3 Statistical models

We used a complete randomized block design with two replications for the experiment design. The descriptive analysis was statistically evaluated using a 3-factor analysis of variance (balanced ANOVA), with judge, wine, and replication as main effects and judge*wine, judge*replication, and wine*replication as interaction effects (Minitab 16, Kivuto, Ottawa, Canada). We also performed a principal component analysis (PCA) with the significant sensory attributes that emerged from the ANOVA procedure. Mean differentiation for all 10 wines was achieved by implementing a protected Fisher's least significant difference test (LSD).

9.1.4 Qualitative analysis

We asked participants to comment on the different wines and attributes and used these qualitative comments to complement the findings in the statistical analysis. The additional comments also provided a more complete analysis and informed the conclusions of the study.

9.2 Experimental results

As shown in Table 9.2, the 10 wines were significantly different for the five following attributes ($P \leq 0.029$): "oak aroma," "oak flavor," "berry flavor," "balance," and "length of finish." "Astringency" showed an interesting trend toward significance at the 95% confidence limit ($P = 0.087$). The overall quality attribute showed not only a significant main wine effect but also a significant judge*wine interaction. The F value was recalculated (Cliff et al., 2015) using the judge*wine error term to identify whether the variance in the scores was primarily due to the wines as opposed to the judges. The resulting calculation indicated that overall quality showed that this attribute was significant at $P = 0.081$ despite the judges' lack of consensus and was therefore included in further calculations. With regard to judge reproducibility, the judge*wine interaction terms were not significant, which suggests a strong concept alignment among the panelists.

As shown in Table 9.2, judge effects had a significant value for all attributes; this was expected in the descriptive analysis because judges used different parts or ranges

Table 9.2 Three-way ANOVA summary of ***F*** values and ***P*** values indicating the source of variation among 10 merlot wines evaluated by six judges in duplicate

	Judge		Wine		Replication		Judge*wine		Judge*rep		Wine*rep	
Attribute	***F* value**	***P* value**	***F* value**	***P* value**	***F* value**	***P* value**	***F* value**	***P* value**	***F* value**	***P* value**	***F* value**	***P* value**
Oak flavor***	10.269	0	4.446	0	3.911	0.054	1.304	0.188	0.527	0.755	1.072	0.402
Quality score***	35.478	0	4.335	0	4.994	0.03	2.428	0.002	2.164	0.075	1.192	0.323
Oak aroma**	15.249	0	2.976	0.007	5.201	0.027	1.254	0.226	1.519	0.203	0.574	0.811
Balance**	13.653	0	2.908	0.008	4.57	0.038	1.218	0.255	1.53	0.199	1.708	0.115
Length of finish**	15.595	0	2.885	0.009	0.705	0.406	1.165	0.305	0.567	0.724	0.774	0.641
Berry flavor*	32.927	0	2.337	0.029	0.254	0.617	1.554	0.072	2.318	0.059	0.428	0.913
Cassis	14.896	0	1.939	0.07	7.329	0.01	1.289	0.199	0.273	0.926	0.744	0.667
Astringency	24.573	0	1.84	0.087	8.348	0.006	1.59	0.062	3.063	0.018	1.25	0.29
Acidity	25.572	0	1.783	0.098	9.274	0.004	0.454	0.995	1.197	0.326	0.669	0.732
Bitterness	8.287	0	1.548	0.161	3.6	0.064	1.06	0.423	0.497	0.777	0.643	0.754
Vegetative	18.414	0	1.334	0.247	0.512	0.478	0.866	0.684	0.285	0.919	1.539	0.164
Green bell pepper	45.584	0	1.221	0.306	0.749	0.391	1.172	0.298	1.666	0.162	1.066	0.406
Vegetal	21.205	0	1.155	0.346	0.398	0.531	1.45	0.108	1.528	0.2	0.548	0.831
Mouthfeel	10.642	0	0.896	0.537	0.568	0.455	1.216	0.257	0.843	0.526	1.343	0.243
Berry aroma	22.87	0	0.603	0.788	0.069	0.794	1.951	0.014	0.705	0.623	0.741	0.669
Spicy aroma	13.873	0	0.493	0.872	2.245	0.141	0.988	0.516	0.394	0.85	0.38	0.939

Significant attributes are highlighted. Level of significance for F wine values ($P \leq 0.05$, $P \leq 0.01$, and $P \leq 0.001$) is indicated by *, **, and ***, respectively.

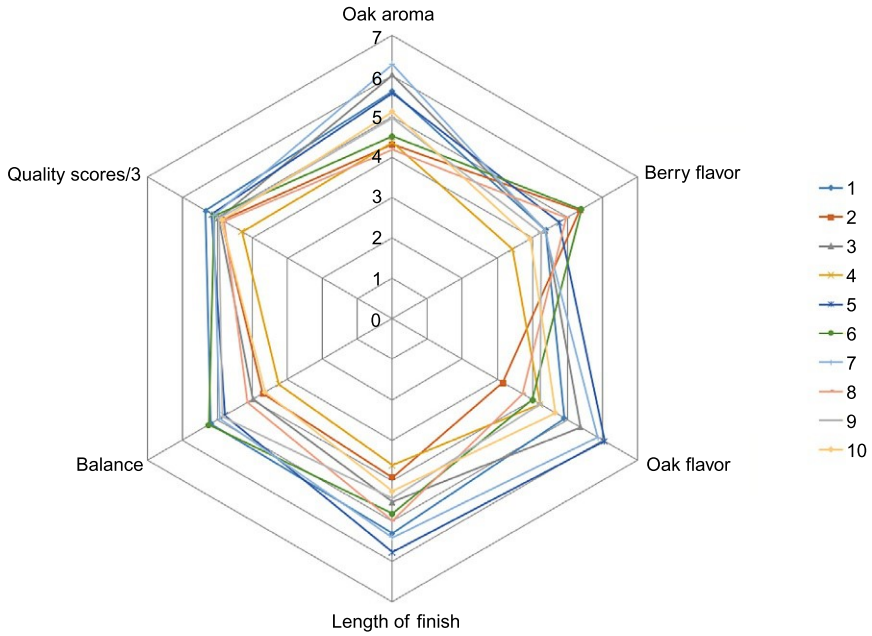


Fig. 9.3 Cobweb diagram with wines' sensory profile for significant sensory attributes and quality score. Quality scores were divided by 3 for a better visualization.

of the scales. This does not compromise the statistical analysis of the sensory data (Guinard, 2006; Lawless and Heymann, 2010). The judges were discriminant and noticed differences among the wines in terms of woody sensory character (e.g., "oak aroma" and "oak flavor"; Noble et al., 1984, 1987) as opposed to vegetal attributes (e.g., "vegetative," "vegetal," and "green bell pepper"), which were not significantly different. Similarly, the wine descriptors "mouthfeel," "astringency," and "acidity" were not significantly different ($P \leq 0.05$). The statistical analysis also revealed significant replication effects for the significant attributes "oak aroma," "balance," and "overall quality," indicating that the overall sample means for these attributes were different across replications. This may have been caused by experimental error (tasting times and dates and room temperature control). A look at the judge*replication and wine*replication interaction effects indicated that they were not significant—proof that the judges were in agreement and that the wine samples used in the two replications were consistent.

For the six significant attributes, a cobweb diagram shows sensory differences among the 10 merlots (Fig. 9.3). Sensory scores represent the intensity of the sensory perception, which is measured using an attribute scale ranging from 0 to 10, with 0 representing "no intensity" and 10 representing "high intensity."

We then used the post hoc LSD test (Table 9.3) to identify differences between sample means. Means that share the same subscript letters are not significantly different ($P < 0.05$). Samples are color-coded for each significant attribute. The similar and different profiles can be contrasted both in Table 9.3 and in Fig. 9.3.

Table 9.3 Mean scores of significant attributes and LSD value for the 10 merlot wines assessed

Ranking assessment											**LSD ($p<0.05$)**
Oak aroma	**8**	**2**	**4**	**6**	**9**	**10**	**5**	**1**	**3**	**7**	
	4.17d	4.3cd	4.25cd	4.5cd	4.95bcd	5.11abcd	5.56abc	5.62ab	6.02ab	6.29a	**1.25**
Berry flavor	**4**	**10**	**9**	**7**	**3**	**1**	**5**	**8**	**2**	**6**	
	3.43c	3.94c	4.24bc	4.35abc	4.36abc	4.38abc	4.76ab	4.97ab	5.35ab	5.4a	**1.14**
Oak flavor	**2**	**8**	**6**	**4**	**9**	**10**	**1**	**3**	**7**	**5**	
	3.15d	3.72cd	4cd	4.22bcd	4.22bcd	4.65bc	4.9abc	5.36ab	5.87a	6.05a	**1.26**
Balance	**4**	**10**	**2**	**3**	**8**	**5**	**9**	**7**	**1**	**6**	
	3.24c	3.63bc	3.69bc	3.93bc	4.14abc	4.78b	4.85ab	4.93ab	5.18a	5.24a	**1.19**
Length of finish	**4**	**2**	**10**	**9**	**3**	**6**	**8**	**1**	**7**	**5**	
	3.61cd	3.92cd	4.26cd	4.43bc	4.52bc	4.81abc	4.99abc	5.3ab	5.4ab	5.77a	**1.14**
Quality	**4**	**8**	**2**	**10**	**9**	**3**	**6**	**7**	**5**	**1**	
	12.87c	14.41bc	14.62ab	14.62ab	14.87ab	14.87ab	15.292ab	15.292ab	15.45ab	16a	**1.57 ($p=0.081$)**

Wines 6, 7, 1, and 5 were perceived as most intense for most significant attributes. The highest intensity scores were rated 6.41 and 6.17 out of 10 for oak aroma and oak flavor, respectively. By contrast, wines 4 and 2 were weakest in intensity for all attributes. Wine 6 was perceived as fruitiest with a berry flavor score of 5.51/10. Wine 2 was rated strongly on berry flavor intensity and mildly on all other sensory properties. Wine 8 exhibited a similar profile but with greater balance and medium length of finish. Wine 4, from the 2011 vintage, was rated as the lowest-quality wine of the flight and weakest in aroma and flavor intensity. Furthermore, as the LSD table (Table 9.3) shows, both wines 4 and 8 are considered of equal quality with both being significantly different from wine 1 ($P=0.081$). The LSD calculations suggest that the 10 wines were significantly different on the oak and fruit intensity spectrum and also differed significantly on how fruit and oak were integrated (balance) and on their level of complexity as perceived by mouth (length of finish).

In order to evaluate the interrelationships among the sensory attributes, we generated a principal component analysis (PCA). PCA is a graphic representation that enables a description and differentiation among wines based on their locations on the plot, relative to the location of sensory attributes (Fig. 9.4).

The PCA biplot shows how the *x*-axis (PC1) is a summary of quality and length of finish, while the *y*-axis (PC2) represents berry flavor and oak flavor/aroma up to a point; PC1 accounts for 49.4% of the data variability, while PC2 accounts for 31.4% of this variability. Both axes account for 80.8% of the variation in the sensory data. For each wine, two data points are represented on the plot and refer to the first and second tastings.

All attribute vectors are similar in length, meaning that all attributes are of the same relative importance in explaining variance in the dataset. All vectors represent positive characteristics of the wines and are found in the right-hand side of the plot. These wines are also more intense in aroma and flavor. In contrast, wines with weaker aroma and flavor intensity are located on the left-hand side of the plot.

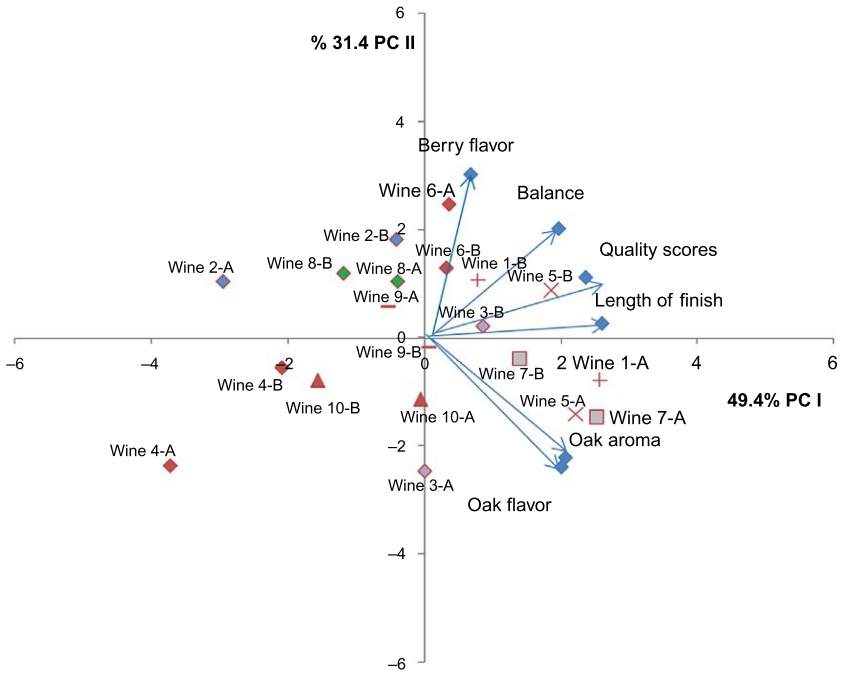


Fig. 9.4 PCA plot.

The top-right quadrant shows those wines perceived as quality wines. These are balanced wines that display good integration of oak—a positive attribute—while preserving fruity characteristics. Their intensity is also defined by the length of their mouth finish. Wines 1, 7, 5, 6, and 3 were rated positively, while wines 2, 4, 8, 9, and 10 were judged more negatively. Wines 5 and 1 are closest to the overall quality vector. Wine 6 is heavily loaded on PC2 so is high in berry flavor and less oaky compared with the other wines. Wine 7 is located near the oak aroma and flavor vectors so is the oakiest of the flight. The attribute correlation matrix (see Table 9.4)

Table 9.4 Correlation matrix

	Oak aroma	**Berry flavor**	**Oak flavor**	**Length of finish**	**Balance**	**Quality scores**
Oak aroma	1	0.351	0.702	0.435	0.355	0.373
Berry flavor	0.351	1	0.267	0.533	0.594	0.33
Oak flavor	0.702	0.267	1	0.477	0.332	0.371
Length of finish	0.435	0.533	0.477	1	0.665	0.4
Balance	0.355	0.594	0.332	0.665	1	0.473
Quality scores	0.373	0.33	0.371	0.4	0.473	1

indicates that oak aroma and flavor are highly correlated. The two overlapping vectors indicate that, in this study, the attributes are redundant. Balance is strongly positively correlated to length of finish, while wine berry flavor is linked favorably to balance and more moderately to length of finish.

9.2.1 Qualitative comments

Panelists were asked to provide personal comments when assessing the quality of the wines. We gathered comments during both tastings for information purposes only. Some of the words used to describe the wines were "complex" in the case of wine 1 and "fruity," almost "artificial," "not complex enough," and "somewhat flat" for wine 6. Although some considered wine 7 very oaky, others considered it fruity. Panelists showed greater consensus in identifying lower-quality wines such as wines 2, 4, and 8. Some issues mentioned with wine 2 included defects and faults related to "overpowering astringency," "*Brettanomyces* defects," "flat profile," and "harsh tannins." Wine 8 also had low overall quality scores; some comments were the "lack of complexity," issues with "*Brettanomyces* and astringency," and the "lack of balance." Wine 4, from the 2011 vintage, achieved the lowest-quality scores. Panelists described this wine as having "*Brettanomyces*," "volatile acidity," and a "slight bitterness"; it was also described as having a "high astringency" and "lacking balance."

9.3 Expert insights and its implications

Our findings indicate that sensory differences exist among varietal wines produced from specific grape-growing areas within the Okanagan Valley. According to our panel of wine experts, a quality varietal merlot destined for the local market is a wine that is flavorful and free of defects and that combines balanced fruitiness and oak character with a long finish and smooth tannins (no astringency). Measuring the wine's key sensory descriptors, specifically fruit and oak character and balance and length of finish, is thus essential to produce a quality wine. Given that some wines may have been defective (*Brettanomyces* and volatile acidity taint), future research should add a defect/off-flavor scale to the list of attributes and capture this information on the PCA plot.

Panelists conducted blind evaluations using precise sensory descriptors, which we then statistically analyzed. Wine professionals rated the wines in such a way that brand-varietal preferences did not impact sensory judgment, thereby minimizing non-sensorial inputs and allowing for a more objective and robust sensory evaluation of the actual attributes of each wine tasted. This is critical since wine flavor serves as an important proxy for wine quality and wine aroma a determinant factor of lesser quality (Hopfer et al., 2012; Lawrence, 2015).

Regarding the overall quality of the wines, wine 4 (2011 vintage merlot) stood out as being of significantly lower quality than all wines except for wine 8 (Naramata merlot) (see Table 9.3). Vintage, wine taints, astringency, and a weak intensity of wine aroma and flavor explain this poor rating.

Although the study sample size is small, our results show that the varietal merlot wine produced in Central Okanagan (wine 6) achieved similar quality to wines produced in the South Okanagan and in the Columbia Valley, two areas favored for their hotter climates.

Meilgaard et al. (1999) state that "the primary function of sensory testing is to conduct valid and reliable tests to provide data on which sound decisions may be made." In our study, sensory testing was achieved using quantitative descriptive analysis. Although a costly tool since it requires the acquisition and training of human resources (Lesschaeve, 2006), in-house or outsourced sensory profiling services may help with the following:

(1) Characterizing wine from designated origins. Cadot and his team showed that while soil and environmental factors were thought to be prevalent in the sensory typicity of the AOC Anjou-Villages-Brissac wines, enological practices (date of harvest and vatting times) had a more important impact on the sensory profile of the appellation (see Cadot et al., 2012), and that interventions were thus needed to preserve the wine sensory characteristics attributed to environmental factors.

(2) Identifying consumer preferences. Sensory profiling has found application in consumer studies by identifying the drivers of wine quality and style. Sensory analysis coupled with market/consumer research can provide accurate insights into what characteristics must be considered when repositioning or improving a consumer product such as wine. Identifying the sensory profile of best-selling wines or pinpointing the likes and dislikes of consumers may help wineries finesse the sensory profiles of their wines to meet market expectations. Consumer-focused research is already practiced by large corporations (Society of Sensory Professionals, n.d.) and other market-driven organizations (Australian Wine Research Institute, 2013; Francis and Williamson, 2015). The Australian Wine Research Institute has conducted such consumer preference studies, for instance. Examples of positive attributes favored by consumers included fruit freshness in red wine and green capsicum combined with tropical profiles in white wine. By contrast, consumers reacted negatively to small levels of *Brettanomyces* yeast-induced compounds (Brett), bitterness, and "struck flint," which is a reductive wine aroma associated with screw-on closures.

(3) Identifying and recognizing taints and defects. Sensory profiling can counter "the cellar palate"—a term describing how a winemaker can no longer detect and recognize taints and off-flavors in his/her wines due to overexposure—and be used as a quality control tool in the winery.

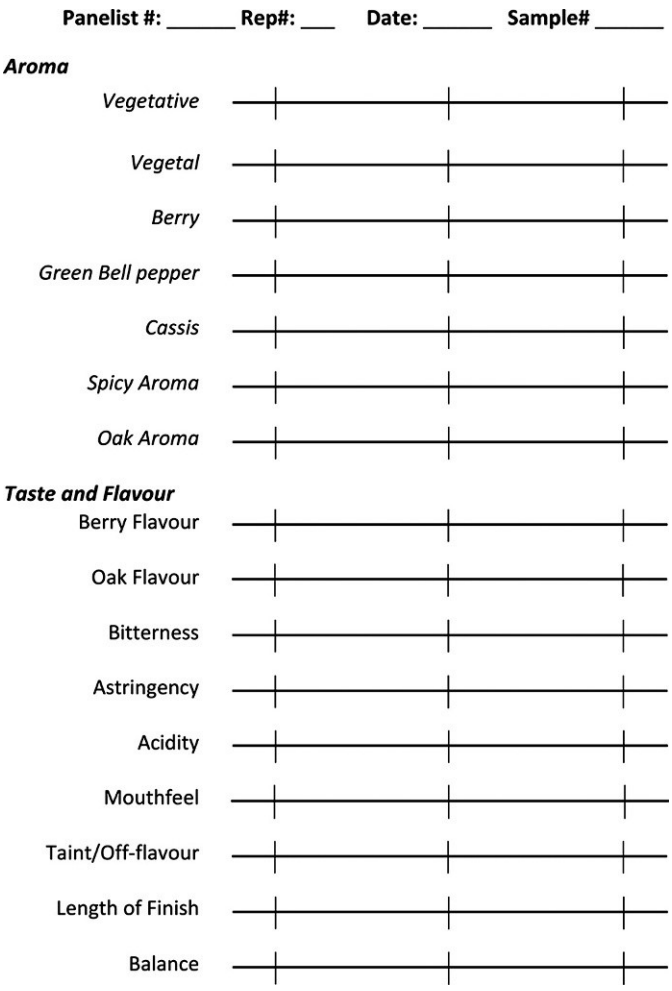
(4) Validating viticulture and winemaking practices in the context of market demand and branding. Used over time, with each vintage, for instance, the sensory tool can track and validate a winemaker's decisions regarding wine style and winemaking practices.

Future research could expand this study by evaluating these same wines while providing panelists with the wines' details to determine if there is any relation between wines' prices and perceived qualities with the sensorial assessments.

Rejuvenating a product, in this case wine, need not be confined to changing sensory attributes; rather, a price change alone can affect rejuvenation. Such changes in a product's profile can reposition it toward a different market niche. For example, because wine number 1 has certain attributes and received a high-quality score, it could be repositioned as a top-quality wine with a price increase. Wines with certain characteristics (e.g., oak or berry profile) can be repositioned toward a niche market that prefers this flavor or olfactory profile.

This project was limited to a specific set of merlot wines from a specific wine region. Future research should consider other varietals and regions, which would be relevant for comparing the specific qualities of each varietal and wine-growing region and for comparing the participants' differences in term of their context. Research topics could include how regional taste preferences or taste developments affect evaluations.

Appendix 1



Appendix 2

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Ranking Assessment

Based on the UC-Davis 20-point scale. Deduct points for flaws and faults.

			Wine 1	Wine 2	Wine 3	Wine 4
			#	#	#	#
Appearance & Colour	Clear/Characteristic	2				
	Slightly hazy/Pale	1				
	Cloudy/Off-colour	0				
Aroma (by nose) Varietal aromas, bouquet from oak and ageing	Complex	4				
	Superior/Good	3				
	Average	2				
	Poor or weak	1				
	Major flaws	0				
Defects and faults Oxidation, VA, sulfur TCA, geranium, Brett	None, clean	2				
	Slight	1				
	Pronounced	0				
Residual sugar Bitterness/Acidity	Appropriate	2				
	Poor	1				
Body & mouthfeel	Appropriate	2				
	Lacking	1				
Flavour by mouth Length of Finish & Balance	Complex	4				
	Good/Superior	3				
	Average	2				
	Poor	1				
Astringency Reds and rosés (add 2 points for whites)	Balanced tannins	2				
	A bit rough	1				
	Harsh & bitter	0				
Overall Quality	Superior	2				
	Average	1				
	Poor	0				
	GRAND TOTAL					

20-Point Scale

Very good, Superior	>17	Below average	14-15
Average to Good	15-17	Poor	<14

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