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Influence of biological, experiential and psychological factors in wine preference segmentation

Gary J Pickering^{1,2,3,4,5} and John E Hayes⁶

¹Department of Biological Sciences, Brock University, St Catharines, ON, Canada

²Cool Climate Oenology and Viticulture Institute, Brock University, St Catharines, ON, Canada

³Department of Psychology, Brock University, St Catharines, ON, Canada

⁴Charles Sturt University, Wagga Wagga, NSW 2678, Australia

⁵University of the Sunshine Coast, Sippy Downs, Qld 4556, Australia

⁶Department of Food Science, College of Agricultural Sciences, The Pennsylvania State University, University Park, PA 16802, USA

Abstract

Background and Aims—We sought to determine the influence of selected biological, experiential and psychological variables on self-reported liking and consumption of wine in a sample of 329 Ontario wine consumers.

Methods and Results—Cluster analysis revealed three distinct groups, representing plausible market segments: wine lovers; dry table wine likers/sweet dislikers; and sweet wine likers/fortified dislikers. These groups differ in level of wine expertise, wine adventurousness, alcohol intake, bitterness from 6-*n*-propylthiouracil (PROP), and several demographic variables. PROP hypo-tasters ($n=113$) and PROP hyper-tasters ($n=112$) differed in liking scores for nine of the 11 wine styles [ANCOVA, $P(F)<0.05$]. When wines were grouped according to their dominant sensory properties (dry, sweet, carbonation and heat), liking scores for PROP hyper-tasters were higher than those of PROP hypo-tasters for all classes. Scores also varied with age, expertise and gender for some products. Effect sizes (eta-squared) were generally greatest for age, and those for PROP responsiveness were of similar magnitude as those for gender. As expected, wine consumption frequency was higher for men and experts, and increased with age.

Conclusions—Age is the most robust and consistent driver of wine liking and intake of the variables examined. Taste phenotype also contributes significantly to variation in wine liking.

Significance of the Study—Ontario wine consumers fall into one of three wine liking clusters, which differ in experiential, biological, psychological and demographic features that can be targeted through branding and marketing strategies.

Keywords

alcohol consumption; expertise; market segmentation; Ontario; PROP; propylthiouracil; taste genetics; wine liking

Introduction

Wine is the world's oldest alcoholic beverage (McGovern et al. 2004), and is the most consumed in at least 20 countries, including France, Italy, Sweden and Argentina (World Health Organization 2011). The flavour of foods and beverages (colloquially 'taste') is the foremost driver of purchase decisions (International Food Information Council 2011). Chemosensory perception, however, is highly variable across individuals (Bartoshuk 2000), so improved understanding of individual differences in sensation is of growing interest to food and beverage producers, due to the relationships between sensation, liking and intake [see Hayes (2015)]. Given the broad diversity of wine styles available, the opportunity for segmentation and targeted marketing is high, and taste phenotyping may provide important insight into identifying and understanding market segments (Pickering and Cullen 2008). Although there are several taste phenotypes described in the literature [e.g. Pickering et al. (2010a), Allen et al. (2013), Webb et al. (2015)], the most studied over the last two decades is the suprathreshold bitterness of 6-*n*-propylthiouracil (PROP). Individuals have traditionally been classified as PROP non-tasters (those for whom PROP elicits no or slight bitterness), PROP medium-tasters (those for whom PROP is mildly bitter) or PROP super-tasters (those for whom PROP is intensely bitter). Differential bitterness of PROP associates with variation in the *TAS2R38* gene, but these polymorphisms do not adequately explain supertasting [see Hayes et al. (2008)].

Importantly, heightened responsiveness to PROP is associated with greater responsiveness to sensations elicited by wine, including heat/irritation (Pickering and Robert 2006), sourness (Pickering et al. 2004, Pickering and Robert 2006), bitterness, astringency (Pickering et al. 2004), and multiple somatosensory sub-qualities (Pickering and Robert 2006), although Pickering et al. (2010b) failed to find such relationships. Also, several recent studies show that those who experience PROP as being intensely bitter not only experience heightened overall oral sensation, but may also be more acute tasters, with the ability to discriminate smaller differences between oral stimuli (Prescott et al. 2004, Lee et al. 2008, Hayes et al. 2010), including wine (Pickering and Robert 2006). How these differences in chemosensory perception are reflected in liking, preference and intake of wine remain largely unexplored in the literature.

Personality factors are often not investigated simultaneously with taste phenotypes, however, evidence suggests personality factors might influence food liking and/or intake [e.g. Goldberg and Strycker (2002), Saliba et al. (2009)]. One such factor, willingness to try new food and beverages, varies across individuals and is often conceptualised as food 'adventurousness' or 'neophobia'. The analog with wine is referred to as 'wine adventurousness' (Hayes and Pickering 2012). Differences in food/wine adventurousness are one possible explanation for contradictory findings on the significance of PROP phenotypes

to real world food/beverage preference, liking and/or intake, as advanced by Ullrich et al. (2004). In their convenience sample of 232 adults, they reported that PROP tasters who were more food adventurous liked chili peppers and hot sauce, other pungent condiments, strong alcohol, and bitter fruits and vegetables more than tasters who were less food adventurous, whereas food adventurousness had little influence on liking in PROP non-tasters. No such mediating effect on wine liking, however, was observed from alcoholic beverage adventurousness in a more recent survey of over 1000 adult consumers (Pickering et al. 2014). As compared to most other foods/beverages, wine can be viewed as a product for which there is a high level of perceived risk in consumers' minds, due to its social cachet, varied nature and complexity (Lacey et al. 2009). As speculated by Hayes and Pickering (2012), this may attach greater importance to individual adventurousness in mediating wine consumer preference and purchase decisions. In a recent study by Olsen et al. (2015), significant differences were found between high variety-seeking US wine consumers compared to moderate variety-seeking and variety avoiders with respect to personal characteristics, values and relationship with wine. For instance, high variety-seeking individuals tended to be younger, hold values favouring stimulation and tolerance of risk, pay more for wine, and consider themselves more wine knowledgeable.

Prior work suggests wine knowledge and sensory ability may together constitute a measure of wine expertise (Frost and Noble 2002). In turn, it would be expected that wine expertise associate with overall liking of wine (presumably high liking is an important motivator in becoming a wine expert) and intake. Wine experts have been shown previously to possess better olfactory recognition than novices (Parr et al. 2002, 2004), and are more likely to experience PROP more intensely (Hayes and Pickering 2012, Pickering et al. 2013). Elsewhere, food involvement and culinary training have been shown to influence perceptual maps and use of descriptors for sensory stimuli [e.g. Byrnes et al. (2015)], however, and rather surprisingly, there is little information on whether or how wine preferences and consumption vary with expertise. In a small study examining red wine, Frost and Noble (2002) found no significant overall differences in liking between groups when segmented on the basis of wine knowledge, or a composite metric combining wine knowledge and sensory expertise. More recently, Johnson and Bastian (2008) reported that wine style consumption patterns in an Australian cohort varied with expertise, while Pickering et al. (2014) found that the level of self-reported expertise predicted liking across all wine styles as well as total intake in US wine consumers. With respect to the related construct of wine involvement, several studies have shown associations with preferences and consumption behaviours. For instance, Thach and Olsen (2015) examined the attributes and behaviours of heavy wine users in the USA based on price segmentation, and found differences in gender, age, income, wine involvement, shopping channel and ecommerce/social media usage.

In this study we sought primarily to examine how varied biological, psychological and experiential factors might influence wine market segmentation using a large wine market as a case study, and to determine how preference for and consumption of wine vary with taste phenotype and other variables. We also wished as a secondary objective to better define Ontario wine consumers.

Materials and methods

Participants

As described previously (Hayes and Pickering 2012), individuals of legal drinking age were surveyed at a range of locations around the Niagara Peninsula, which included: local LCBO stores (in Ontario, wine and spirits are sold through government-owned shops run by the Liquor Control Board of Ontario); staff, faculty and students at Brock University; Niagara Peninsula wineries; and wine events on and off the Brock campus. The Brock University Ethics Board cleared all procedures, and participants gave written informed consent before commencing. As an incentive, participants were entered in a random draw for one \$200 book voucher.

Questionnaires

Participants ($n=329$) who reported consuming alcohol beverages were asked to complete a brief questionnaire that collected basic demographic data (age, gender and ethnicity), and key measures detailed below.

Wine expertise—Participants were asked to indicate their wine involvement by endorsing the following items: I drink wine only on rare occasions; I drink wine occasionally; I am a professional winemaker; I am a wine writer; I am an LCBO Product Consultant; I am another type of wine professional; I serve or have served as a judge of commercial wine at wine show(s); None of the above. They were allowed to check as many items as were applicable (259 endorsed one item, 61 endorsed two, and ten endorsed three). Among the 51 individuals who indicated they were ‘another type of wine professional’, 11 were amateur winemakers, ten were winery workers, nine were wine merchants, and five were winery owners. Individuals were classified as ‘wine experts’ if they were professional winemakers, wine writers, LCBO consultants, wine judges, or some other type of wine professional ($n=110$). All other participants were classified as non-experts ($n=219$).

Wine adventurousness—Participants were asked ‘how often do you try wines that you haven’t tried before?’, and responded using a 4-point Likert scale: ‘Never’, ‘Rarely’, ‘Some of the time’, and ‘Most of the time.’ As reported in Hayes and Pickering (2012), we collapsed across response categories to dichotomise individuals into high or low groups, collapsing the first three categories into ‘some of the time or less’ for comparison to ‘most of the time’. For wine adventurousness, 164 individuals fell in the low group and 163 in the high group.

Liking and intake—Liking of wine was determined by participants rating their liking of a list of 11 traditional styles presented with examples on a 7-point hedonic scale (Lawless and Heymann 1998) ranging from ‘Like extremely’ to ‘Dislike extremely’. The styles were: dry white, sweet white, red, rosé, dry sparkling, sweet sparkling, dessert, port, dry sherry, sweet sherry and fruit wine. Participants could also indicate allergy, lack of exposure to the style, and lack of knowledge of the style in lieu of providing a liking rating. These data were collected before widespread introduction and adoption of generalised hedonic scales to the

field [e.g. Lim et al. (2010), Kalva et al. (2014), Hayes et al. (2015)], so such scales were not used here.

Frequency of consumption of wine and total alcohol was measured by participants indicating how many days per month they consumed beverages from the categories 'white wine', 'red wine', 'beer', 'spirits' and 'other'. Participants checked the appropriate response from the following frequency options: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15–19, 20–24, 25–29, 30. Responses were then multiplied by 12 to obtain an annualised estimate of consumption frequency for each participant for wine (white wine + red wine) and total alcohol (white wine, red wine, beer, spirits + other).

Propylthiouracil phenotyping—Response to PROP was determined after the method of Zhao et al. (2003) using filter paper disks impregnated with 50 mmol/L PROP. Participants placed the disk on his or her tongue, allowing it to moisten with saliva. They then rated the perceived bitterness of PROP using a generalised labeled magnitude scale [gLMS; Bartoshuk et al. (2004)], anchored at the top with 'strongest imaginable' sensation. A candy was then provided to participants to help alleviate any lingering bitterness.

The distribution of PROP intensity scores is shown in Figure 1. As the distribution does not indicate a tri-modal distribution, and as classification of individuals into the more traditional non-, medium-, and super-taster groupings may not be the best approach given the polygenic nature of PROP tasting (Rankin et al. 2004), we instead examined the responses of participants from both ends of the PROP responsiveness spectrum. Specifically, participants were divided into tertiles; for convenience, the high group ($n = 112$) will be referred to as hyper-tasters, and the low group ($n = 113$) as hypo-tasters. The 33rd and 66th percentile fell at 17 and 48, respectively, on a 100-point scale. We use the terms hypo- and hyper- tasters here instead of the more traditional non-taster and supertaster labels because those labels typically imply a 25/50/25 partitioning scheme, which is based on the outdated assumption that suprathreshold bitterness is a Mendelian trait. That is, such categorisation schemes were implicitly based on the speculation that taster homozygotes (TT) would be supertasters, while taster heterozygotes (Tt) would be medium-tasters, with tt homozygotes being non-tasters; contemporary molecular data indicates this is not the case (Hayes et al. 2008).

Data treatment and analyses

Unless otherwise indicated, all analyses were conducted using XLSTAT (Version 2012.1.01, Addinsoft, Aernach, Germany). For all ANOVA, ANCOVA and Chi-square tests, alpha was set at 0.05.

Cluster analysis—Agglomerative hierarchical and K-means clustering techniques were used to classify participants according to their preferences for the 11 wine styles. Agglomerative hierarchical clustering (Dissimilarity proximity type, Ward's method, Euclidean distance) revealed three clusters based on the dendrogram plot. K-means clustering [criterion: Trace (W); nearest neighbour estimation for missing data] was used to classify the participants. Each cluster was then compared for gender, age, ethnicity, wine expertise, wine adventurousness, yearly wine and alcohol consumption frequencies, PROP intensity and

PROP classification (hypo- vs hyper- tasters). Clusters were examined using one-way ANOVA for the quantitative variables and Chi-square for qualitative variables (Table 1).

Wine liking and consumption: PROP, age, gender and expertise—An ANCOVA was completed in which liking scores for each wine style were the dependent variables, and age (co-variable), gender, wine expertise, PROP classification (hypo- or hyper-) and all two-way interaction were independent variables. When two-way interactions were not significant, the ANCOVA was repeated without the non-significant interaction term(s). This model reduction approach was done to increase parsimony by using simpler models wherever possible, increase interpretability of main effects and to increase statistical power by conserving degrees of freedom. Effect size estimates for gender, age, expertise and PROP responsiveness were quantified using the eta-squared statistic. To further examine what sensory drivers may underlie the association of PROP responsiveness with liking, wines were placed into a priori groups based on their dominant sensory properties and investigated using ANCOVA (as described above). The groupings were: DRY (dry white, dry sparkling, dry sherry), SWEET (sweet white, sweet sparkling, dessert, port, sweet sherry), CARBONATION (dry sparkling, sweet sparkling) and HEAT (port, dry sherry, sweet sherry). Annualised consumption frequencies (wine only and total alcohol) were also examined with ANCOVA as described above.

Results

Three hundred and twenty-nine participants completed the study; 56% participants were male and 44% were female (mean age = 44 years $\pm$ 13 SD).

Segmentation

Following cluster analysis, three distinct groupings of consumers can be visualised in Figure 2. Group 1 is the smallest group, and with only 65 participants caution should be applied with interpretation. Nonetheless, this group is characterised by high liking scores for sweeter wine styles (sweet white, sweet sparkling, dessert and fruit wines), and relatively low scores for the three fortified styles (port, dry sherry and sweet sherry). Thus, they can be conceived as ‘sweet likers’, ‘fortified dislikers’. Table 1 indicates this group are much younger than other clusters, more likely to be female, more ethnically diverse, drink alcohol less frequently, and wine is a lower proportion of their total alcohol intake frequency. Group 2 ($n = 167$) provide high liking scores for all wine styles, and may be conceived of simply as being ‘wine lovers’. They are much more likely to be wine experts/professionals, are more wine adventurous, and have a high frequency of alcohol intake. The third group ($n = 97$) shows significantly higher liking of dry table wines (dry white and dry red), and tends toward giving low ratings for sweet wines, so we have named them ‘Dry table wine likers, sweet dislikers’. They are older, have a relatively low level of wine adventurousness, drink wine more frequently than other alcoholic beverages, and are more likely to be PROP hypo-tasters. Pickering et al. (2014) previously reported an inverse association between age and PROP responsiveness.

Influence of PROP responsiveness, age, gender and expertise on liking

Overall, mean wine liking scores ranged from 3.78 (sweet sparkling) to 6.18 (red), with a global average of 4.7. Table 2 shows the key results from the ANCOVA, and Table 3 indicates relative effect sizes for the independent variables. Age was significant for six wine styles, including the major categories of dry white and red, and consistently showed the largest effect size. Age also mediated the effect of other factors on liking scores for some wines, as indicated by significant two-way interactions between these factors and age. Expertise was also an important factor, associating with wine liking for nine of 11 styles. Interestingly, there was no interaction between expertise and PROP responsiveness for any wine. Gender was significant for only two styles—dry sparkling and dry sherry, with men giving higher scores for both (data not shown). Notably, PROP responsiveness was significant for nine of 11 wine styles, and the effect sizes observed were generally comparable to those observed for gender. As shown in Figure 3, PROP hyper-tasters gave higher liking scores than hypo-tasters for wines, with the exception of red wine. The reversal for red wine may be driven by the high astringency of red wine; generally, greater astringency associates with lower liking [e.g. Fleming et al. (2016)] and astringency is reported to be more intense in those who report greater PROP bitterness [e.g. Pickering et al. (2004)]. Logically, it follows that greater astringency may be more aversive for PROP hyper-tasters, thereby depressing liking. We reran the analysis (Pearson's r) using PROP bitterness as a continuous variable; it was positively and significantly associated with liking of sweet white ($P=0.04$), rosé ($P<0.01$), dessert ($P<0.01$), port ($P=0.02$), and fruit ($P<0.01$) wines, and approached significance for sweet sparkling ($P=0.057$) and sweet sherry ($P=0.067$) styles.

We also investigated the association of PROP responsiveness with wines grouped according to their dominant orosensory properties (Table 4). As shown, PROP hyper-tasters gave higher liking ratings for all wine groups, including those whose dominant sensations may be considered aversive at high intensity (e.g. carbonation and heat). When PROP bitterness is considered as a continuous variable (Pearson's r), it is positively and significantly associated with the sweet ($P<0.01$), heat ($P=0.04$) and carbonation ($P=0.01$) groupings, but not the dry wine grouping ($P=0.29$).

Consumption frequency—Among this sample of individuals recruited from wine related events, an analysis of both annual wine ($F=0.89$, $P=0.347$) and total alcohol ($F=0.11$, $P=0.737$) consumption frequency revealed no difference between PROP hypo- and hyper-tasters. Estimated annual frequency $\pm$ SD for wine for hypo- and hyper-tasters, respectively, was 225 ± 173 and 229 ± 174 , and 369 ± 254 and 338 ± 218 for total alcohol, respectively. To ensure that the failure to observe a relationship was not an artefact due to binning individuals into groups, we reran this analysis using PROP bitterness as a continuous variable. Consistent with the ANOVA tertile-based analysis, Pearson's correlation coefficients showed no relationship between PROP intensity ratings and wine ($r=0.005$, $P=0.932$) or total alcohol ($r=-0.057$, $P=0.305$) intake frequencies. By contrast, intake frequency of both wine ($F=5.6$, $P=0.019$) and total alcohol ($F=9.5$, $P=0.002$) varied with gender, with men consuming wine (26%) and total alcohol (33%) more frequently. Age associated with frequency of wine intake ($F=13.6$; $P<0.001$) and showed a marginal relationship with frequency of total alcohol intake ($F=3.5$, $P=0.062$); in both instances,

intake frequency increased with age. As expected, experts reported a higher frequency than non-experts for both wine (44%) and total alcohol (38%) (wine, $F = 21.0$, $P < 0.001$; total alcohol, $F = 15.9$, $P < 0.001$).

It has been suggested that food-liking ratings may be a better predictor of real world consumption habits than traditional measures of dietary intake due to recall biases and memory / cognitive demands (Duffy et al. 2007, 2009, Sharafi et al. 2015); similarly, it has been suggested that liking scores of alcoholic beverages might serve as a proxy for actual consumption. We examined the relationship between liking scores for white and red wine and self-reported monthly consumption frequency for these styles. Liking scores for dry white wine and sweet white wine were averaged to provide an estimate of overall white wine liking. R -values and corresponding probabilities for white and red wine were 0.32 ($P < 0.0001$) and 0.49 ($P < 0.0001$), respectively.

Discussion

Ontario is Canada's most populated province (14 million), and her greatest wine consumer. Sales of wine by volume, value, and as a proportion of all alcoholic beverages have shown significant and sustained growth in Canada over the last several years, and are increasing at a rate that surpasses many larger global wine regions (Pelling and Hira 2012, Statistics Canada 2013). We are not aware, however, of any prior literature on consumer segmentation of the Canadian or Ontario wine markets, although Bruwer et al. (2012) reported on differences in consumption behaviour and wine type preferences of males and females and between generational cohorts in a survey of tasting- room consumers in Ontario. Additionally, much of the international literature on wine segmentation has not examined variation in liking across a wide range of available wine styles. Nonetheless, our 'wine lovers' and 'sweet likers, fortified dislikers' clusters appear to share some common demographic characteristics with, respectively, the 'connoisseur' and 'beverage wine drinker' segments, that have been identified in previous studies (Spawton, 1991, Hall and Winchester 2000, Thomas and Pickering 2004). Additionally, the liking clusters extracted here are broadly similar with those identified recently in a sample of wine consumers from upstate New York, USA (Pickering et al. 2014). Further data on the characteristics of the three clusters identified here are needed to enable a fuller comparison with market segments described in other countries/cohorts, and to assist with targeted marketing to these Ontario consumers. Information on income, values and lifestyle characteristics (Bruwer et al. 2002) would assist in this regard.

Age was a significant source of variation in liking scores for the majority of wine styles, and its effect size was the highest of all the factors. It is possible that this reflects in part the greater experience with wine of older consumers. That is, they have had more time and opportunity (e.g. disposable income) to sample a wider range of styles and wines within a style, and thus have a better sense of what each style represents and what they do and do not like. Additionally, younger consumers in this cohort showed a clear preference for sweeter wines, in contrast with older consumers who preferred drier styles, and this accounts for some of the age effects observed. This latter finding should assist wine producers in optimising the sweetness level for specific age segments, and marketers in aligning their branding and advertising efforts to consumers of different ages.

While the differences in liking between the two extreme PROP groups were generally small, they are consistent, suggesting a robust effect. Further, the effect sizes for PROP responsiveness were similar to, and in many cases larger than, that of gender, and liking was greater for PROP hyper-tasters for all wine categories when grouped according to dominant orosensory properties. Initially, the present data may appear to contradict other reports that those who experience more bitterness from PROP (Duffy et al. 2004) or sampled ethanol (Nolden and Hayes 2015) consume alcohol, including wine (Pickering et al. 2014) less frequently, due to lower liking (Lanier et al. 2005, Pickering et al. 2014). Indeed, taste phenotype has even been proposed as a protective factor against developing alcohol dependence (Pelchat and Danowski 1992). Our cohort, however, differs from most other reports in one critical respect: our sample excludes non-drinkers via self-selection and has a high level of wine involvement; thus our cohort generalises only to those individuals who have learned to enjoy and regularly consume alcohol, not to the general public as a whole. In the broader population, it remains likely that greater bitterness, astringency and burn discourage alcohol intake and acquisition of a strong preference [e.g. Pickering and Robert (2006)]. Pickering et al. (2014) found that total wine intake decreased with PROP bitterness, and liking of dry, sparkling and fortified styles—whose dominant sensations are nominally aversive—were lower for PROP super-tasters. Notably, their cohort was less involved with wine than ours; annualised frequency of consumption in our sample was 59% higher (227 vs 143 standard drinks), and only 14% of their cohort rated their wine expertise as high or greater, whereas a full third of our sample was wine professionals.

Among individuals who have already learned to enjoy and drink alcohol, analysis of two distinct datasets suggests that greater PROP bitterness associates with increased likelihood of being a wine expert (Hayes and Pickering 2012, Pickering et al. 2013). It has been hypothesised that among individuals who have both learned to like alcohol and have a strong interest in wine, greater innate taste ability may provide some sort of competitive advantage that in turn may increase the probability of making the effort to become an expert (Hayes and Pickering 2012). This speculation is based on the observation that those who report more PROP bitterness have a more acute sense of taste (Prescott et al. 2004, Lee et al. 2008, Hayes et al. 2010), including greater discriminatory capacity for wine texture (Pickering and Robert 2006) and higher wine flavour responsiveness (Pickering et al. 2006). Presumably, greater capacity to discriminate finer sensations and therefore appreciate the complexity of a complex sensory product may encourage the latent connoisseur to put forth the effort to acquire expertise through additional training. Likewise, it has been reported that culinary school students are much more likely to report stronger bitterness from PROP than the general population (Bartoshuk et al. 2004). As a caveat, we should note that a latent ability to taste smaller differences between wines is not, and should not be construed as, a substitute for training, technical knowledge, and content area expertise.

Overall, the association between wine liking and frequency of consumption observed here was only weak to moderate; again, however, we should note this was among a group specifically recruited from wine related events, and therefore may not generalise to a broader population. To the extent that consumption frequency may mirror total alcohol intake, caution should be applied in using wine-liking data as a proxy for actual consumption. Notably, disliking may be more tightly coupled with disuse than liking is with use. That is, I

may like single malt scotch very much, but limit my intake due to cost or health concerns, whereas if I dislike gin, I do not drink it regardless of other factors [see Hayes (2015)]. It is important that future work critically considers the composition of different wines and wine styles, as well as the influence they may have on the dominant sensory properties of the wine. For example, the quality of ethanol shifts from bitter to burn with increasing concentration (Nolden and Hayes 2015), so attempts to associate biologically driven differences in sensation [e.g. Allen et al. (2014), Nolden et al. (2016)] to alcohol use behaviours need to keep this in mind, especially given the relatively high level of alcohol that may be found in fortified wines. Additionally, especially for wine, factors such as residual sugar also need to be considered, as protective effects of individual differences may be attenuated in sweetened alcoholic beverages [see Running and Hayes (2016)].

As well as contributing to fundamental knowledge on the drivers of wine consumer liking and consumption, our findings also provide some guidance to wine practitioners, particularly those involved with marketing and sales. Wine style preferences parse out into three distinct clusters, each of which is characterised by consumers who differ in socio-demographic and other key features that can be targeted through traditional branding and marketing strategies. For instance, Group 2 are highly adventurous with their wine purchases; thus their demographic may be more receptive to new products, such as novel varietal blends, and represent a desirable cohort for prototype development or early-launch advertising activities. Conversely, Group 3, which is characterised in part by older consumers, tends to like only dry white and red wines, therefore marketing efforts for other wine styles may best be directed toward other consumer segments. Finally, males and experts drink significantly more wine, and thus may be more profitable to target in advertising campaigns and channel-specific promotions than other groups.

Conclusion

Ontario wine consumers can be segmented into three distinct and plausible market segments, based on their liking of a full range of commercial wine styles. For the first time, we report on the relative effect sizes of biological, experiential and psychological factors thought to influence wine liking and intake within a single cohort of individuals, and conclude that age is the most robust and consistent driver of those variables examined. Taste phenotype (operationalised via PROP responsiveness) and wine expertise also appear to be important components of the multifactorial nature of wine liking and, in the case of expertise, consumption, and their consideration in future studies will contribute to a more comprehensive understanding of behaviours related to alcoholic beverages.

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Figure 1. Frequency distribution of 6-*n*-propylthiouracil (PROP) scores. Arrows indicate lower and upper tertiles.

Figure 2. Profile plot from cluster analysis of wine liking scores showing three groups: cluster 1 (■); cluster 2 (■); and cluster 3 (□). [K-means clustering – criterion: Trace (W), after agglomerative hierarchical clustering (dissimilarity proximity type, Ward's method, Euclidean distance)].

Figure 3. 6-*n*-Propylthiouracil (PROP) responsiveness and wine liking for a range of wine types by PROP responsiveness [PROP hyper-tasters (□) and PROP hypo-tasters (■)]. Data shown are mean liking scores (7-point hedonic scale) ± standard error. Means significantly different (ANCOVA – model in text) at alpha of 0.05 (*), 0.01 (**) or <0.001 (***).

Table 1

Characteristics of wine-liking segments.

		Group 1	Group 2	Group 3
Gender [†]	Male	44.6%	63.5%	51.5%
	Female	55.4%	36.5%	48.5%
Age [‡]		35 ± 14	45 ± 12	49 ± 12
Ethnicity	White	85%	95%	98%
	South Asian	3%	1%	1%
	Latin American	3%	-	-
	Other	9%	4%	1%
Wine expertise [§]	Experts	15%	55%	8%
	Non-experts	85%	45%	92%
Wine adventurousness [¶]	Low	62 %	36%	67%
	High	38%	64%	33%
Annualised intake frequency	All alcohol ^{††}	218 ± 234	443 ± 250	317 ± 204
	Wine ^{‡‡}	108 ± 118	295 ± 179	199 ± 150
	% Wine/all alcohol	49.5%	66.6%	62.8%
PROP intensity ^{§§}		38.6 ± 29.5	37.7 ± 26.6	30.9 ± 26.3
PROP responsiveness ^{¶¶}	Hypo-	49% (21)	43% (51)	64% (41)
	Hyper-	51% (22)	57% (67)	36% (23)

[†]Chi-square = 8.0, $P < 0.05$ ($df = 2$).[‡] $P(F) < 0.0001$.[§]Chi-square = 72.4, $P < 0.0001$ ($df = 2$).[¶]Chi-square = 26.9, $P < 0.0001$ ($df = 2$).^{††} $P(F) < 0.0001$.^{‡‡} $P(F) < 0.0001$.^{§§}Not significantly different between cluster groups ($P(F) > 0.05$).^{¶¶}Chi-square = 7.3, $P = 0.027$ ($df = 2$).PROP, 6-*n*-propylthiouracil.

Table 2

F-values from analysis of covariance of wine liking scores.

Wine style	Age	Gender	Expertise	PROP responsiveness	Significant interactions (F-value, sig.)
Dry white	12.1 ^{**}	3.3	22.6 ^{***}	2.7	-
Sweet white	7.2 ^{**}	3.3	3.3	4.1 [*]	Age*expertise (9.2 ^{**})
Red	15.6 ^{***}	0.1	10.1 ^{**}	13.0 ^{***}	Age*PROP (12.4 ^{***})
Rosé	2.5	0.4	18.3 ^{***}	4.2 [*]	-
Dry sparkling	0.5	10.1 ^{**}	31.8 ^{***}	5.1 [*]	Age*gender (8.3 ^{**})
Sweet sparkling	8.2 ^{**}	1.0	2.7	3.5	Age*expertise (5.1 [*])
Dessert	5.9 [*]	0.7	7.3 ^{**}	7.4 ^{**}	-
Port	0.2	1.8	11.2 ^{***}	4.7 [*]	-
Dry sherry	0.0	5.1 [*]	8.9 ^{**}	3.9 [*]	-
Sweet sherry	2.5	2.6	5.2 [*]	4.7 [*]	-
Fruit wine	4.0 [*]	1.3	16.3 ^{***}	5.6 [*]	Age*expertise (20.5 ^{***})

* significant at 0.05, 0.01 and 0.001, respectively. PROP, 6-*n*-propylthiouracil.

** significant at 0.05, 0.01 and 0.001, respectively. PROP, 6-*n*-propylthiouracil.

*** significant at 0.05, 0.01 and 0.001, respectively. PROP, 6-*n*-propylthiouracil.

Table 3

Effect size (eta-squared) for factors associated with wine liking.

Wine Style	Age	Expertise	Gender	PROP responsiveness
Dry white	0.329	0.101	0.034	0.005
Sweet white	0.382	0.083	0.039	0.047
Red	0.545	0.046	0.008	0.025
Rosé	0.29	0.095	0	0.042
Dry sparkling	0.311	0.166	0.021	0.027
Sweet sparkling	0.39	0.02	0.006	0.067
Dessert	0.199	0.062	0.003	0.055
Port	0.264	0.1	0.029	0.03
Dry sherry	0.262	0.068	0.051	0.006
Sweet sherry	0.284	0.05	0.018	0.028
Fruit wine	0.4	0.001	0.009	0.047

PROP, 6-*n*-propylthiouracil.

Table 4

6-*n*-Propylthiouracil responsiveness and liking scores for wine grouped by orosensory properties.

Orosensory quality	<i>F</i> -value	<i>P</i> (<i>F</i>)	Mean liking scores ($\pm$ SD)	
			PROP hypo-tasters	PROP hyper-tasters
Dry	4.6	0.003	3.49 $\pm$ 1.06	3.68 $\pm$ 1.18
Sweet	7.5	0.007	4.06 $\pm$ 1.65	4.70 $\pm$ 1.39
Carbonation	7.3	0.008	3.95 $\pm$ 1.76	4.61 $\pm$ 1.42
Heat	5.2	0.024	4.15 $\pm$ 1.72	4.65 $\pm$ 1.59

PROP, 6-*n*-propylthiouracil.