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A taste of science: Making the subjective objective in the California wine world

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Abstract
This article is about the relationship between the categories of the subjective and the objective in the late 20th-century California wine world, about attempts to transform 'soft' subjective judgments into 'hard' objective descriptions and evaluations, and about the role of both sensory science and chemistry in such attempts. It focuses on research done at the University of California, Davis, from about the 1950s to the 1980s by the enologist Maynard Amerine, his co-workers, and successors. It suggests ways in which these materials might prompt attention to the role of subjective judgment and the marketplace in other forms of late modern science.

Keywords
enology, flavor chemistry, linguistic reform, objectivity, olfaction, subjectivity, taste, wine

One question about objectivity concerns what it is; a cluster of others concern how it is accomplished, warranted, attached to bodies of knowledge, and marked out from the subjective modes considered to be its opposites. The first question has greatly occupied philosophers, while the others have increasingly drawn the attention of historians and sociologists, writing about what has *counted as* objective knowledge, truth, or fact in different times and places and about how objective standing has been accomplished.[1]

This is an exercise of the second type: I describe a cultural and scientific practice that was greatly concerned with attaining objectivity and that worried about the penetration of certain kinds of contaminating subjective elements – making objectivity impossible, confusing the one with the other. This was a practice that reflected on and developed a

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specific set of institutionalized practices meant to secure and maintain objectivity. The materials treated here are modern, dealing primarily with developments in California during the post–World War II decades. They are closely linked to commercial concerns – making and evaluating products on the market. And, most pertinently, the objectivities involved are, by other accounts, forms of subjectivity. More disengaged observers might discern subjective elements in the advertised objectivity and *vice versa*. Neither objectivity nor subjectivity in these domains is a pure form: The labels are stipulations about how to evaluate and regard different forms of knowledge and the practices meant to secure them. The relevant knowledges are, by one set of criteria, weak and soft; by other criteria, knowledges like these – objectified subjectivities – are pervasive and powerful in modern societies.[2]

The subject is 20th-century American enology – the sciences dealing with winemaking, with the exception of growing wine grapes (which goes under the name 'viticulture') – and related strands of wine and flavor chemistry. One concern of these practices was how the organoleptic properties of wine – those that act on the senses – can be reliably described, communicated, and made to reflect what wine is really like: The issue was how the identifiable constituents of wine cause the sensory experiences that can be so described.

This article is one of a pair in this issue of *Social Studies of Science*: here I treat questions about the language used to describe the sensory experiences involved in consuming wine and with the sciences involved in discovering flavor components in wine. I focus on some practices in academic enology and flavor chemistry, but I also deal briefly at the end with the ways in which non-academic, and non-scientific, connoisseurs and wine writers also attach words to sensory experiences. An accompanying paper by Christopher Phillips (2016) describes efforts to take a set of subjects' sensory experiences and reports and then process these subjectivities into objectivities, where that processing involved the management of tasting conditions, the disciplining of subjects' sensory reports, and, especially, the statistical manipulation of their judgments.

Maynard Amerine: A modern taste-maker

Maynard A. Amerine (1911–1998) was 20th-century America's most influential enologist, and, while he published some papers on aspects of wine chemistry, on judging wine at shows, and on growing and making wine – notably on the crucial matter of which grape varieties grew best in each of California's climatic regions (Amerine and Winkler, 1944; Winkler and Amerine, 1937) – the focus here is on his influential work on what he called the 'sensory evaluation' of wine. The son of a Central Valley peach grower, Amerine got his doctorate in plant physiology at Berkeley in 1935. By that time, he had already begun working in a new department at Davis – about 75 miles northeast of San Francisco – which, when Davis was transformed from California's farm school into a full-fledged university in the 1950s, was eventually called the 'Department of Viticulture and Enology'. The university had special responsibility for supporting California agriculture and the new department was tasked with assisting the state's wine industry to recover from the depredations of Prohibition, repealed in 1933, and with assisting in developing products that might have a chance of competing against European wines in

the marketplace (Lapsley and Sumner, 2014: 184–185; Pinney, 2012: 172–173). The problem Amerine confronted was less about excellence than goodness, in the sense of soundness, in a period during which California winemakers knew little about European varietals and about which varieties would flourish and have satisfactory yields in which climates (Pinney, 2012: 182–183, 188). Amerine did little or no remunerated industrial consultancy or work directly concerned with the market for wine, though wine as a commercial good is central to this story.

For Amerine, the development of objective ways of establishing and talking about wine properties was closely linked to establishing the authority of academic enological expertise, but these practices were framed by commercial realities. It was appreciated that wine judged to be free of the defects that were then common in California products had a better chance of market success, and that reliable ways of communicating organoleptic characteristics were matters of commercial interest (Amerine, 1959b). From early in his career, Amerine intermittently corresponded with California winemakers about how better to integrate academic enological expertise in the production of wine. Amerine did not have a high opinion of the ability of ordinary American consumers' ability independently to discern quality or to distinguish one type of wine from another, though he thought it possible that they *might*, with experience and good instruction, acquire such capacities in the future. This was one reason why purported experts *did* have marketplace authority and why only legitimate experts, using objective techniques, *should* have such authority.[3]

Returning from the Army's Chemical Warfare Service after World War II, Amerine became full professor in 1952 and chair of department from 1957 to 1962, retiring from Davis in 1974 but continuing an active writing life, as well as arranging dinners and tastings for the trade's Wine Institute in San Francisco. He published extensively – hundreds of articles in the technical literature and 16 books – including some meant for a more general readership.[4] He taught or mentored many of America's growing numbers of winemakers and offered popular short courses in winemaking.[5] From 1951, Amerine offered a hugely popular course at Davis on wine appreciation ('Viticulture 1') to students who were not going on to become wine professionals, and this, together with his more popular writings, eventually helped to shape American lay taste. His obituary in the *New York Times* referred to Amerine as 'the father of American wine'. He was a member of, and wine steward for, San Francisco's men-only, elite, and famously louche, Bohemian Club; and, while living alone and never marrying, Amerine was a frequent and flamboyant host of connoisseurs, the rich and the famous (O'Neill, 1998). He was a figure of both national and international importance in setting standards for assessing wine quality.

Taste's history

From Antiquity, consumers have oriented to tastes and odors in wine; the sensory experience of wine was indeed part of the pleasure wine gave; different wines were recognized by their characteristic sensory palettes; and it was widely acknowledged that there were some sensitive and experienced experts who could reliably tell one wine from another, who could detect fraudulent or adulterated wines, and who might be depended

upon, with qualifications, to pronounce on relative quality (Grappe, 2007; Grieco, 2009; Shapin, 2011, 2012b). There were always tendencies to describe wines in terms of the pleasures they afforded – however ordinary wine consumption might be, wine was regarded as a hedonic object – and, in the Victorian and Edwardian periods, especially, to describe wines in aesthetic terms. High-toned literary or artistic references were standard among the educated classes: One wine might strike a drinker as like a particular poem; another might be compared to star-light, a babbling brook, or an Old Master painting; the flavor profiles of others were parsed into 'masculine' and 'feminine'; the sensations produced by some wines were 'noble', one type of wine was the 'king' of drinks, another the 'queen'; one was Beethoven, another was Brahms (Shapin, 2009). That is to say, for a very long time, it was understood that the sensory profiles of wines might be attended to with respect to pleasure, to physiological consequence, to aesthetics, and to their geographical identity and authenticity – but without any systematic or focused attempt analytically to *describe* the aspects of taste or smell. An authentic and well-made Chambertin tasted like Chambertins and not like Vosne-Romanées. An attentive and sensitive drinker might recognize and distinguish them, or even their different vintages, domains and bottlings, without sorting out, identifying, and describing the component tastes and odors, which, when aggregated, made up the total experience. It might, or it might not, be considered legitimate to talk about wines in terms of *what they made you feel like*, or *what they reminded you of*, rather than in terms of what they *really were*, so to speak, in the glass, or in terms of distinct sensory aspects or components (Peynaud, 1987 [1983]: 29).

Another historical tradition bearing on mid-20th-century enology and related scientific practices was formally distinct from consumers' and connoisseurs' accounting: the chemistry of wine and, to an extent, the sensory physiology that sought to describe and explain how people experienced wine as a sensory object. Specific components in wine thought to bear on its flavor were known for a very long time and certainly before the 19th-century development of the categories and processes of organic chemistry. For example, the experience of sweetness was understood to be an effect of a sweet-tasting component in wine, even before chemical experts parsed sweet-tasting substances into such sugars as glucose and fructose. The intoxicating properties of wine were widely attributed to what was called 'spirits of wine' before this was recognized as ethanol, a substance with some bearing on the taste and texture of wine. Similar knowledge and presumptions related to the experience of acidity and the presence of tartaric and malic acids were known before the atomic composition or structure of such things was established. And the same applies to the sensory experience of astringency, with reference to familiar drying substances like tannins. So, insofar as both scientific experts and engaged laypeople described the sensory experience of wine in terms of its organoleptic constituents, such references concentrated overwhelmingly on what could be tasted as opposed to what could be smelled and on constituents that were present in wine in large concentrations rather than on volatile odoriferous components that, by the 19th century, were understood to be present in very small amounts, such that their chemical identities were beyond the reach of then-available techniques.[6]

Modern sensory physiology distinguishes rigorously between gustation – taste in the strict sense – whose palate sensors detect the limited repertoire of sweet, sour, salty,

bitter, and umami (the newly identified savory or meaty taste), on the one hand, and olfaction (smell), on the other. While the fundamental varieties of odor and the mechanics of olfactory stimulation are still imperfectly understood, odor is experienced with far greater complexity and subtlety (Geldard, 1972: 471–479; Goode, 2014: 171–178).

In common vernacular, and in some expert, practice, and from the distant past to the present, the notion of 'taste' tends to fold together olfactory and gustatory experiences. In more rigorous terms of technical art, the term 'flavor' is meant to encompass both olfaction and gustation, the total sensory experience of consuming wine through all pertinent sensory channels – smell and taste, of course, but also chemical and temperature senses, the tactile sense and vision – and, though this is only occasionally spelled out, the role of memory, the emotions, prior beliefs, and expectations.[7] The apparent sensory jumble designated by the notion of 'flavor' can elide distinct sensory channels, but it also can reflect the seamless integration of modes that one experiences when drinking wine as opposed to the special occasions when one might intentionally parse its aspects. The notion of 'synesthesia' is now technically used to designate unusual or pathological associations between sensory modes, but it can also point to the sort of everyday integration of modes captured by the concept of flavor.[8] That said, usage has been, and remains, unstable: Some present-day professionals do not make rigorous distinctions between sensory modes, others write as if the context of use will make clear what's involved in various references to taste, and still others evidently see little interest in such distinctions, leaving them to relevant scientists. So, in the 19th century and into the first part of the 20th century, the organoleptic characteristics of wine belonged to different traditions and different ways of accounting, but the relationship between them was not particularly contested, and there was little, if any, tendency to identify one as legitimate and the others not.

Practical objectivity in modern enology

Part of the reason for the absence of any serious contest between the objective and the subjective – between chemistry and connoisseurship – was the technical capacity of chemical science. The 19th- and early 20th-century chemists knew they were a long way from identifying the molecular causes of specific odors, partly because there was little lay tradition of parsing component wine odors, and mainly because chemists' techniques were recognized as inadequate to identify low-concentration volatile components.[9] The same chemists intermittently hoped for progress, imagining a future state in which words for sensations would attach to unique chemical causes of such sensations.[10] The prospect was that we might always have to live with Volnay tasting like Volnay and with all instances of fine wine having Lord Chesterfield's famous 'je ne sais quoi'.

By the late 1940s and early 1950s, Amerine was turning his attention to a program of what he called the 'sensory evaluation of wine', culminating in an influential book, *Wines: Their Sensory Evaluation* (Amerine and Roessler, 1976[11]), written with his Davis colleague and long-time collaborator, the statistician Edward B. Roessler (1902–1993). This book was the first systematic attempt to make widely accessible a rigorous, academically sanctioned framework for assessing wine quality and describing and reliably communicating its organoleptic characteristics. Amerine and Roessler had a substantial impact on how critics and consumers came to think about wine (Lanchester, 2008).

Sensory evaluation in Amerine's style involved sorting experiences, judgments, representations, and related procedures into categories he called 'objective' and 'subjective'. That sorting was as unstable as it was consequential. In the post-War period, and as more work was done on sensory evaluation, some notable scientists in the area cited historical and philosophical reasons for why the word 'subjective' – having been identified with an inferior grade of knowledge – should either be replaced or used in quite specific senses. The English psychologist Roland Harper, for example, noted in the 1960s that '(a)t one time, the use of the human senses to provide information about the impact of food and other products or stimuli would have been referred to in terms of "subjective evaluation" or "subjective judgment"'. But, he added,

> there are strong arguments in favour of dropping the word 'subjective' and substituting the word 'sensory' … [T]he word *subjective* carries with it an aura of overtones and assumptions which imply that subjective data are unreliable and not to be trusted, in contrast to the scientific respectability of objective data. (Harper, 1964: 601)

The notion of subjectivity was to be reserved for what was unreliable and untrustworthy, notably in an area where subjects' sensations and knowledge were the objects of systematic and rigorous inquiry.[12]

Amerine evidently saw sense in this suggestion, and his work on sensory evaluation generally used the term 'subjective' in its deprecatory aspect. Amerine and his colleagues drew on objective–subjective distinctions for all sorts of purposes. The distinctions were enlisted to establish legitimate understandings of what wine was like as a sensory object and how one could institute reliable ways of describing its sensory aspects. Though Amerine never gestured at any formal philosophical account of objectivity,[13] his usages had a family resemblance to notions of scientific method widely distributed in mid-century American culture. Yet the sorting of objective and subjective in Amerine's program of sensory evaluation was no mere philosophical detour. Knowing how to gauge which sensory experiences reliably reported on real organoleptic properties was central to effective communication in the wine world and also to producers' efforts to do what they could to reproduce the experiences that gave satisfaction to consumers and that might make for market success.[14]

Amerine had much experience judging wine at California shows, and he recognized that judging was as problematic as it was practically necessary. By one definition, judging was inevitably subjective, since it concerned the reports of subjects on their sensory experiences. So to say that you wished to know what wines were like as objects was to say that you wanted relevant knowledge that was necessarily subjective – knowledge of subjects' sensations and their evaluations of those sensations. It was well understood that subjects varied in sensitivity, that their standards for what wines should be likewise varied and that their liking of wines also varied. Judgment differed between individuals, and notoriously, it might differ between acts of judgment by one individual (Amerine et al., 1959: 477; see also Phillips, 2016). That instability might be recognized as a kind of subjectivity needing expert repair. How could judges orient to sensory experience to make their reports focus on real properties? What was needed to establish a vocabulary of assessment that would make sure the order of words reproduced, or came close to reproducing, the order of material and sensory realities?

The evaluative and practical opposition between objective and subjective was central to the programs of sensory evaluation that Amerine and his associates developed from the 1950s. One form of the contrast pointed to an attitudinal stance. Approaching wine in an 'emotional, intuitive, or romantic' frame of mind was what Amerine called 'subjective', while a 'reasoned, analytic or classic' style counted as 'objective'. Here, objectivity amounted to something like the notion of disinterestedness: it was the intentional embrace of a cool, matter-of-fact, broadly 'scientific' approach to sensory experience (Amerine and Roessler, 1976: 2–5). For the most part, it was individual professional experts or judges who were said to be capable of approaching wine in an objective mode. They sought to orient to wine analytically, in its discrete organoleptic aspects; they had, or ought to have had, collectively agreed-upon procedures to notice, to describe, and to evaluate; and they learned, and learned reflectively to embrace, the discipline in which they put aside the purely subjective domain of liking or disliking: 'Generally their personal preferences in wines do not come into play or are consciously ignored. This is why it is vital for the judges to have common, fixed standards for each type of wine' (Amerine and Roessler, 1976: 9–10). Amerine and other experts in sensory evaluation knew very well that there were people who assessed wines in largely non-analytic modes, but, on the whole, these modes were thought to be either inferior or otherwise unsuitable to the task of the 'professional': the judge, the winemaker, or the wine writer. Objectivity here attached to different types of people, their different modes of cognitive and emotional engagement, and their intentional states.

'The most important requirement of any wine is that it give pleasure', Amerine wrote (Amerine and Singleton, 1965: 292). He was no ascetic, and he was fully aware that wine was, inescapably, an emotion-producing substance, something that, as often consumed, belonged to Dionysian hedonism rather than to Apollonian reason. He briefly dismissed the notion that an objective engagement with wine detracted from enjoyment. Like many reflective scientists, Amerine insisted that analysis of sensory 'factors' did not detract from, but might in fact enhance, genuine aesthetic response: 'The greater our understanding of the factors that affect our reactions to wines, the greater our confidence to judge them and the keener our capacity to enjoy them' (Amerine and Singleton, 1965: 292–293). A proper aesthetic response was, then, the putting together, or synthesis, of sensory experiences that had first been subjected to factorial analysis. An alternative sentiment – that a legitimate and an informed holistic subjective experience did not *have to* proceed by aggregating and summing up analytic moments – was not, apparently, entertained.

In Amerine's view, the experience of pleasure was distinct from the ability to recognize and describe the sensory factors that might or might not give pleasure. Pleasurability was, from his view, inherently subjective: No one but you could experience it, and there was nothing you could effectively say about it apart from some attempt to rank it with respect to other pleasures (Amerine and Roessler, 1976: 129–130, 145–146). '[W]e must ultimately make our own decisions', Amerine said. Though we are alone in our pleasure, under certain conditions we may come to agree about what a wine is *like*, even one that gives me great pleasure and you very little. Without evident awareness, Amerine and his colleagues were rehearsing a key distinction in classical aesthetics between *taste* and *judgment*, the former a matter of subjective, emotional, and private preference and the

latter a matter of evaluation based on shareable, rationally disputable, and potentially objective criteria that represent the properties of a thing one might like or dislike.[15]

Amerine and his colleagues thought that there might, indeed, be a causal relationship between knowledge of a wine's characteristics and the pleasure it gives: 'Our first reaction to an aesthetic object such as wine is apt to be *subjective*, we like it or dislike it. For a more lasting judgment, however, we apply objective criteria, consciously or unconsciously'. Individual variation in pleasure must be accepted as an inevitable fact, and, provided that such assessments were 'based on experience and considered judgment we must accept them at face value' (Amerine and Roessler, 1976: 5). Elsewhere, Amerine suggested a possibility that quality judgments *might*, in the remote future, bypass human agency and be mechanically produced, but for the present, one had to accept that both the quality of wines and the pleasure they afforded were 'of a subjective nature'. One should, nevertheless, expect that such subjective assessments be rendered by judges who are experienced, sensitive, and disciplined (Amerine et al., 1959: 477, 560; Amerine and Roessler, 1976: 129–130).

Objectivity in sensory evaluation might also involve a sort of intentional internalism. It entails a focused engagement with wine as an object, alongside a concomitant bracketing of irrelevant and potentially distorting considerations said to be extrinsic to that object. This sort of focus, and this segregation of the intrinsic from the extraneous, was not easy to achieve, and failure to attain it indexed amateurism: 'We hasten to admit', Amerine wrote, 'that our sensory responses, and especially our perceptions of quality, are often modified by a variety of physiological and psychological factors and cultural influences'. Everyone is 'susceptible' to such influences, but the sensory professional learns to avoid them and to 'refine his sensory skills'. The professional recognizes 'the shibboleths of the wine snobs' and how to ignore them. It was the emotional 'romantics' and the unreconstructed subjectivists who allowed themselves to be influenced by such extrinsic considerations as labels, reputations, years, producers, regions, and the like, all of which are 'incidental' to the wine itself. Some of these 'incidentals' were intentionally engineered by advertising and market institutions – what Amerine called 'Madison Avenue hucksters'. The 'actual quality' of a wine was determined by *the object itself* – 'the sensory quality of the wine in the glass' – and 'not the words on the bottle label, or the price or the excellence of the advertising'. Even though objectivity in evaluation was meant ultimately to assist market judgments, objectivity in this sense was opposed to the forces of commerce. By attending to real properties and real sensations, you could 'ignore with confidence both the ad agencies and the wine snobs' and make your own judgment of what wines were like and how good they were (Amerine and Roessler, 1976: 5–6). If you stood against the hype of the wineries and their ad agencies, Amerine wrote, you were accused of being 'anti-American Big Business and *ipso facto* pro-Communist or, at least, a socialist' – when all you were really doing was telling the plain truth (Amerine, 1966b: 35).

'By contrast, the classic approach', Amerine announced, 'pays little attention to such external matters and seeks to discover the underlying reasons for a wine's good or bad qualities'. The wine itself, and only the wine itself, was the proper focus of objective engagement: '[W]hatever quality a wine has is found in the glass, not in books, charts or anything else'. If you were serious about objective sensory assessment, it was the

'classic approach' that, Amerine stressed, leads to '*more consistent, defensible results*' (Amerine and Roessler, 1976: 3, 17; emphases in original). There was nothing here about inherent sensitivity; innate sensory endowments were indeed reckoned to vary, but very many people, if not everyone, could learn such discipline (Amerine and Roessler, 1976: ix–xi). Objectivity here presumed not only an orientation to the 'wine itself' but also the focused engagement of a free, disengaged, and competent sensing subject. Amerine said that 'Generally [judges'] personal preferences in wines do not come into play or are consciously ignored' and they subject themselves to 'common, fixed standards' (Amerine and Roessler, 1976: 10). Judges de-personalized themselves or were assisted by others to do so.

A special sort of learned orientation to sensory experience was one way in which the notion of objectivity was used, but that experience was to be made manifest in distinctive reports on that experience. Amerine was not alone in suspecting that much talk about wine that seemed to be about its sensory aspects was inaccurate, fanciful, or intentionally deceitful. Linguistic reform was needed, if you wanted a higher standard of evaluation for the wine world than the subjective disorder of talk about quality in the art world. Amerine took up that reform in the 1950s and it was carried on throughout his career, and then afterward by his successors at Davis and elsewhere.

There were, then, many sorts of desired objectivity – and undesired subjectivity – at play in Amerine's writings on sensory evaluation. Objectivity involved some notion of 'scientific method' for engaging with wine – adopting an analytic approach, rejecting what counted as extraneous concerns, and arranging a de-contextualized context for assessing organoleptic characteristics. It could indicate a valued rigor and systematicity on the part of judges, and it could point to a purposeful separation of those characteristics that were deemed open to rational discussion and agreement from those that were mere matters of individual associations and preferences. Finding a volatile chemical compound that causes specific odors might also be considered an objective move. Finally, the notion of objectivity in sensory evaluation was – always and everywhere – attached to some appropriate processing of subjective experiences and judgments. The objective and the subjective were persistently opposed usages expressing, as it were, the good and the bad, the reliable and the arbitrary, but, from a more disengaged point of view, each category enfolded aspects of the other.

Analysis and objectivity

The reform of wine talk proceeded analytically: Sensory evaluation was sensory analysis.[16] Instead of responding holistically to the overall sensory impression that a wine made, you were to attend separately to, and then describe, its various constitutive elements, and Amerine specifically linked the notions of the objective and the analytic in commending his 'classical' approach and dismissing the 'romantic' tradition. The 'romantic' typically dealt with integrative notions, such as 'balance', 'harmony', 'complexity', and the like, but you could not speak intelligibly about such things unless you had first talked about the individual factors that might constitute the balance, harmony, or complexity of the whole sensory experience. First came factor-analysis, and then, and only then, could there be aggregating and synthesizing of the gauged factors to arrive at an overall assessment.

Scoring wines, to arrive at a numerical assessment of their quality, had a history going back at least to the late 19th century. By Amerine's time, the 20-point scale institutionalized at Davis was one of many scoring systems used around the world, but here the total score was arrived at by adding up variously weighted factors that ought to be considered in assessing quality – so many points for satisfying criteria of appearance (2 points), color (2), aroma and bouquet (4), and so on. (In terms of art, *aroma* generally refers to wine odors for which the grapes themselves are directly responsible, while *bouquet* designates those complex odors arising from fermentation and aging.) Wines that satisfied established standards of goodness for each factor were awarded the maximum points allowable, or where factors were faults (bitterness, volatile acidity), maximum points indicated an absence of the relevant defect (Amerine and Roessler, 1976: 121–129).[17] Many problems, however, arose from *any* scoring system: How did you justify the categories and their relevant weightings? How could you select judges competent to perform the evaluations? How could you assess their reliability, momentarily and over time? How might you deal with differing evaluations by different judges? In contrast to this factorial approach, holistic reactions were sometimes identified as 'sensual', compared with the studied intellectualism of focused analysis: What the experienced judge learns over time is to enjoy wine as 'a complex mixture of intellectual and sensory pleasures' (Amerine and Roessler, 1976: 5; Phillips, 2016). Holistic assessment was here opposed to objectivity.

Descriptions ought to refer to real properties. Wines were, for example, red or white or pink, were more or less sweet, more or less acidic, might have degrees of astringency or bitterness, and might differ in viscosity and texture. And these visual, gustatory, and tactile properties should be a solid basis of any descriptive language pretending to objectivity. While naïve tasters might not have a proper frame of reference for gauging acidity or astringency, such skills were understood to be straightforwardly attainable through application and experience, while visual assessment was considered even less problematic. Tasters were instructed to direct their attention sequentially to one factor after another. For example, they should note color before smelling or tasting (Amerine and Roessler, 1976: 68–70). Then they should consider sweetness (experienced almost immediately and at the tip of the tongue). Then they were to note the brightness and sharpness of acidity (on the sides of the tongue). Then the sensation of astringency or bitterness might appear after some seconds (experienced mostly by tactile sensors in the central posterior portion of the tongue). Finally, judges should note the viscosity and other textural elements, the 'mouth-feel', of the wine (tactile sensations available all over the tongue and mouth). Tasters might also want to note the persistence of these palate factors, and some of those belonging to olfaction, after the wine is swallowed or expectorated: Such sensations may persist for many seconds or even a few minutes, and can be assessed under the headings 'finish', 'after-taste', or 'length'.

Three main principles informed Amerine's reform of descriptive language: (1) descriptive words should refer to authentic sensations, (2) descriptors should be capable of facilitating reliable reference and reliable communication, and (3) descriptors referring to authentic sensations should, in principle, represent things that actually exist in the wine and that might be the causes of those sensations. The project of making wine language objective first sought to eliminate the sort of fanciful talk that then circulated in

the fashionable world of conspicuous consumption, social distinction, and marketing. By the late 1930s, these ways of talking were well enough known to be targeted in James Thurber's famous *New Yorker* cartoon, with the host's pompous invitation to his guests to enjoy 'a naïve domestic Burgundy without any breeding', hoping that they will 'be amused by its presumption'.[18]

A glossary in Amerine and Roessler's (1976) text on sensory evaluation dealt sternly with a series of then-popular wine descriptors, 'mak[ing] a plea for less fanciful terms than those so often found in the popular press' and urging that descriptive language 'must have recognizable meanings with respect to the sensory evaluation of wines' (Amerine et al., 1959: 490; Amerine and Roessler, 1976: 194; see also Shesgreen, 2003).[19] On Thurber's 'naïve': 'Used for wines of little merit, by persons who presume – but lack – knowledge'. 'Elegant': 'a quality judgment. We try to avoid such terms', along with such related words as 'stylish', 'breed', 'character', and 'noble'. 'Mellow': '[A] word that means different things to different people. If it refers to the sweet sensation, why not say so?' The list included terms that, despite remaining popular among consumers and wine writers, Amerine reckoned had no stable and definable meaning. One of these was 'flinty' – then and now widely used to describe an odor of such wines as Chablis, white Graves, and Mosel Rieslings – the referent of which Amerine said he had never experienced. There was a long list of words that Amerine did not bother to discuss but that he recommended should be either avoided or used with circumspection. These included some terms classically employed but for which Amerine no longer had any use, for example, 'austere' and 'mild'. Then there was pompous vocabulary like 'masculine', 'feminine', 'finesse', 'silky', and 'voluptuous'. All such terms had to go; the words had no definable objects in the wine or in resulting sensory experience, could not be stably used to communicate what wines were like, and, although Amerine was too civil to say so, they were probably just bizarre inventions.[20]

Amerine was especially concerned with language describing wine defects. Flawed wine, wine that could not be marketed because of its obvious-to-all faults, was a major concern when winemaking was a less controlled process than it now is, and defects were of special interest in a New World setting where many of the grape varieties and resulting wines were frankly 'experimental'. So Amerine and other enologists of the period were concerned with factoring the odors of 'good' wine, but they were more focused on detecting, designating, and, ultimately, avoiding the odors and tastes of 'bad' wines, wines that were, for example, oxidized, over-sulfured, sour, spoiled by volatile acidity, possessing foreign odors and tastes, and so on. The now much talked-up 'earthy' odor – these days widely approved as a marker of *terroir* and sometimes designated as *goût de terroir* or *Erdgeschmack* by Amerine – had a different object and a different value for him and many other 20th-century writers. This was simply an unpleasant dirtiness, possibly, though not certainly, caused by earthy substances contaminating the barrels or fermentation vessels (Amerine et al., 1959: 495; Amerine and Roessler, 1976: 197; Grazzi-Soncini, 1892: 46). Similarly, the descriptor 'petroleum' (or 'petrol') – for many people a much-valued odor in aged German Rieslings – was, for Amerine, another smell he said he had not encountered but which, if detected, was possibly caused by contamination from gasoline (Amerine et al., 1959: 537; Amerine and Roessler, 1976: 201; Lehrer, 2009 [1983]: 103).

Another set of odor terms addressed by Amerine was linked to what was then becoming a leading edge of research in wine and food chemistry. Confidence was emerging that at least some of the components of aroma and bouquet, including those that distinguished one grape variety, or type of wine, from another, might be causally ascribed to specific, identifiable compounds present in wine at very low concentrations. This is largely a story that developed from the mid-20th century, and especially from the 1970s, but there were several historical precedents, including the identification in the 1830s by the great German chemist Justus von Liebig and the French chemist Théophile-Jules Pelouze of a substance, œnanthine (or œnanthic ether), that was eventually widely pointed to as a basis of *the* odor of wine, or, more specifically, as 'the odor of old wine', or 'a substance found in the best French wines'.[21] It was a chemists' category, and not one used by more than a very few connoisseurs, but it wasn't meant to pick out what made one 'good' wine smell different from another: Œnanthine was offered as a chemical basis for some notion like 'winey-ness' or 'good-winey-ness'.[22]

Apart from gestures at chemically caused wine defects, Amerine's writings in sensory evaluation from the 1950s through to his 1976 text made only intermittent references to the wine odor language founded in chemical analysis. He did announce his approval of descriptive words that had 'definite chemical meaning', those terms for organoleptic substances familiar in everyday life, known for a long time in the laboratory or that could be easily made known through reference samples: 'acetic' (vinegar), 'hydrogen sulfide' and 'mercaptan' (rotten eggs), 'biacetyl' or 'diacetyl' (an oxidized odor), and 'butyric' (you have to know it already, but some substances that have its odor include Parmesan cheese, rancid butter, and human vomit; Amerine, 1953: 252; Amerine and Roessler, 1976: 194–196, 199, 202; Lehrer, 2009 [1983]: 6). And on rare occasions he addressed specific desirable or normal varietal odors for which a cause had been much more recently proposed in a low-concentration volatile chemical. In 1959, for example, he acknowledged new research identifying the characteristic odor of wines made from Muscat grapes with 'linalo[o]l or a derivative of it'. But at the time he also said that there was as yet 'little information' on the chemical nature of various wine odors (Amerine et al., 1959: 500–501). In a mid-1960s survey of organic molecules in wine, Amerine (1964b: 461–463) devoted just 3 out of 150 pages to aromatic substances, and his listing of wine aromatics was relatively short, referring generically to relatively high-concentration substances – aldehydes, ketones, and 'more than 22 organic acids and other grace notes that have not yet been identified' (Amerine, 1964c: 46). The chemistry of wine odors was advancing rapidly over this period, as the number of identified aromatic molecules in wine was increasing, but still in 1976, Amerine had little to say about chemical specificity. Notably, the sensory evaluation book reported very recent work in which the well-recognized 'green pepper' ('capsicum', 'green-olive', or 'herbaceous') aroma in wines made from Cabernet Sauvignon (later also Sauvignon Blanc) was identified with 2-methoxy-3-isobutylpyrazine, a substance previously identified in green peppers: 'Once recognized by the consumer [the odor] is not easily forgotten' (Amerine and Roessler, 1976: 27, 198).[23]

Amerine's early research included some limited chemical work on higher concentration aromatic substances: For example, in the late 1940s he reported on furfurals whose presence was an indication of high temperatures in winemaking and which gave a

'cooked' quality to wines, rarely desirable and usually considered a fault (Amerine, 1948). Amerine worked with a technician, Cornelius (Corny) Ough, who took on the operative part of chemical research on acids, sugars, and glycerol.[24] In principle, the chemical analysis of wine odor *might* be a powerful objectifying resource, but, Amerine considered, in practice such prospects belonged to the future. 'It would be very desirable', he wrote in 1959, 'to replace organoleptic examination with chemical analyses', that is, to use chemical analysis as a proxy for human senses and so fully to objectify the subjective qualities of wine flavor. 'Some progress has already been made', Amerine said, though mainly with respect to wine *defects*, such as those associated with sulfur dioxide and volatile acidity (Amerine et al., 1959: 559; also Amerine, 1959a: 31). Amerine acknowledged that new analytic techniques offered 'definite promise' in establishing varietal identity, but '[f]or some time to come, sensory tests', especially supplemented with statistical analysis, 'will fill an important place in control and evaluation …' (Amerine, 1960: 381, 1966a: 28–29, 1966c: 1626; Amerine and Ough, 1964: 716). Early in his research in sensory evaluation, Amerine showed that some sorts of organoleptic judgment could indeed be *predicted* by using analytic data – that is to say, facts about chemical constituents – but these data tended to refer to such gross characteristics as total acidity, pH, sulfur, overall ester and aldehyde content, and color (Baker and Amerine, 1953). Beyond that, he reckoned that such objectifying possibilities remained limited: 'There are many difficulties in replacing organoleptic examination with chemical analyses … [O]ur knowledge of the influence the chemical constituents have on odor is still very incomplete' (Amerine et al., 1959: 560; also Amerine, 1958).

Flavor chemistry and its techniques

Despite Amerine's caution, the field of flavor chemistry in general and the chemical analysis of wine odor in particular were undergoing huge changes during the later stages of his career. Twentieth-century research in both flavor chemistry and flavor perception was powerfully propelled by several major institutional concerns. One was the growth of the branded food and drink industry – its concern with quality control and with the development and acceptability of new products; the other was the military, when, during the Second World War, the poor troop uptake of nutritionally well-formulated rations drove the Army Quartermaster Corps toward systematic engagement with lay perception of flavor and its relationship with chemical substances in food (Meiselman and Schutz, 2003; Peyram, 1990). Both industry and the military enlisted the expertise of important industrial consultancy firms such as Arthur D. Little in Cambridge, Massachusetts (Arthur D. Little, Inc., 1958: 65–74), and the American Chemical Society responded by establishing a flavor division in 1965 (Teranishi et al., 1999: 2). By the middle of the 20th century, there were institutional constituencies for chemical techniques that might identify flavor molecules that had profound sensory effects but whose concentration in foods and drinks was very low.[25]

Among the new analytic techniques that could satisfy these demands was gas–liquid chromatography (GC). GC had been introduced in organic chemistry in the first decade of the 20th century, but the technique was greatly advanced in the early 1950s and put to work in flavor chemistry in major ways from the late 1970s and early 1980s.[26] A sample

containing a mixture of volatile substances is vaporized and the constituents migrate up a heated column, carried along by a chemically inert gas. Compounds move through the column at different rates according to their physical and chemical properties and may be precisely identified in extremely low concentrations by mass spectrometry, nuclear magnetic resonance, or other analytic instruments.[27] (It is currently estimated that the total non-ethanol aromatic content in wine is only about 1 g/L, or 1 percent of the ethanol content, and that some of the more pronounced aromas are caused by substances present in extremely small amounts – in the case of the pyrazine responsible for the green pepper aroma, perhaps 2 ng/L, or about half-a-drop in an Olympic-sized swimming pool (Ribéreau-Gayon et al., 2006: 214–215).[28]) In the version known as gas chromatography-olfactometry (GC-O), developed from the mid-1960s and coming into prominence in the 1990s, a 'sniffing port' allows human assessors to report upon and record the sensations of specific odors and to determine which of the many volatile substances are indeed odorants, contributing to the overall smell of the product considered. GC-O can establish the thresholds at which odors are detected and the intensity with which they are experienced at various concentrations, allowing subjective qualities to be causally related to the chemical compounds moving through the column at specific times (Bakker and Clarke, 2012: 230–231; Van Ruth, 2001). A GC-O instrument is a device for identifying objective facts of the matter about wine chemistry, for establishing objectivity–subjectivity causal pairs, and, potentially, for developing a new chemically grounded language of subjective qualities. It is a hybrid instrument: One bit of it is glassware and electronics intended to establish objective chemical facts about aromatic substances, and another bit is the human nose, attached to human beings reporting on their own sensory experiences. Here are two modes of objectification. The one is meant to render knowledge of chemical substances objective; the other to objectify the subjective qualities of human sensory experience.

Amerine and Roessler's (1976) text on sensory evaluation came at an inflection point in the development of flavor chemistry and, especially, in the use of GC to establish the identity of aromatic wine constituents. Amerine evidently understood the achievements of GC in flavor chemistry as they then stood, but the techniques did not have much influence on his vision of the future of sensory evaluation or the future of referential wine talk. Despite Amerine's lack of enthusiasm, GC techniques have, in recent decades, been a major source for expanding knowledge of wine odorants. You might now designate an odor by the name of its causal chemical, offering up a sample of that chemical as a reference of the wine odor component, or you might, without necessarily knowing the causative chemical, designate an odor by the name of a more familiar thing (fruit, vegetable, mineral, animal product) that might plausibly be thought to contain the same characteristic organoleptic substance as the wine in question.

Hundreds of volatile compounds in wine have now been identified, though only some are thought to play a role in wine odor (Bakker and Clarke, 2012: 156–216; Jackson, 2008: 270–310). Wine chemists, for instance, now refer a violet–raspberry scent in Pinot Noir to the ketone β-damascenone; orangey notes in Chardonnay to α-terpineol; botrytized odors of Sauternes (and related sweet wines) to γ- and δ-lactones; and a spicy odor in Syrah to the phenolic ketone zingerone – all present in extremely low concentrations and joining with many other odorants in producing the characteristic aroma and bouquet

of various wines. Varietal-specificity is evident in the 'petrol' odor in appearing in certain Rieslings, an odor much valued by certain consumers and regarded as a fault by Amerine and some producers. This has been ascribed to 1,1,6-trimethyl-1,2-dihydronaphthalene (TDN), mainly produced from precursors during the aging process (Simpson, 1978, 1979). Recent research has shown that TDN is present in far higher concentrations in young Riesling wines than in any other grape variety (Sacks et al., 2012).

Odor and intersubjectivity

This emerging new vocabulary for talking about the organoleptic properties of wine was given greater plausibility by instances of what GC had established about specific chemical causes of specific odors. These links are evident in an artifact produced in the 1980s by the scientist who in 1974 succeeded Amerine in his Davis professorship, the sensory scientist and flavor chemist Ann C. Noble. In 1984, when Amerine had given up substantial research in the field, Noble was appointed by the American Society for Enology and Viticulture to its Committee on Sensory Evaluation, tasked with standardizing the vocabulary of wine odor, that is, to carry on and to institutionalize some of the basic impulses of Amerine's original program. The committee oriented to groups that were part of the wine industry, rather than to consumers, and the intention was to produce descriptive terms that were 'analytic and free of hedonic or value-judgment connotations' – that is, in their usage, objective. The hoped-for virtue of such a language was its capacity to facilitate reliable communication among winemakers, marketers, researchers, and writers, a means to eventually put in place international 'reference standards'. The committee made up a list of 'analytic terms', mailed them out to over a hundred individuals, and received 70 responses (Noble et al., 1984).[29] Three years later, the committee had completed its work; its proposals had been well received; minor modifications had been made; and the proposed vocabulary had been compared with existing attempts in France and elsewhere (Lehrer, 2009 [1983]: 42–50, 190–191; Noble et al., 1987).

Noble later produced a graphic version of the result, the 'Wine Aroma Wheel' (Figure 1), and made it available for sale to the public as an 8.5 inch diameter plastic device.[30] The users of the Wheel were not presumed to be expert judges and panelists but ordinary consumers wanting to increase their knowledge of wine and to talk more coherently with each other about their sensory experiences. They confronted a sample of wine, and, referring to the Wheel, were prompted first to make category judgments – presumed to be least problematic and least specific – about initial broad organoleptic characteristics (the innermost ring of the wheel). Was the wine fruity, or floral, or nutty, or spicy, and so on? Having made that initial judgment, people were then asked (middle ring), if the wine was fruity, whether they thought it smelled of berries, or citrus, tree fruits, or tropical fruits. If they considered that it smelled of tree fruits, they were then offered (the outermost ring) the choice of apples, peaches, cherries, and so on. That ring was the terminus of the standardized descriptive aroma vocabulary, and its terms could be used to communicate reliably both within the group assembled and between people concerned with wine odor, removed in space and time. The wheel is an *intersubjectivity engine*: It is intended to allow people to coordinate their subjective experiences and to agree about the language to be used in sharing those subjective experiences with others.

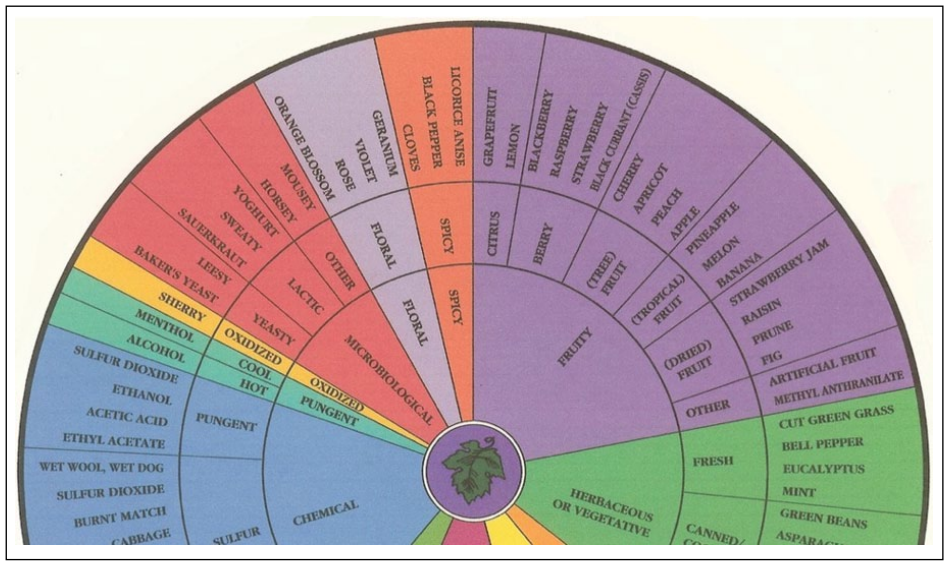

Figure 1. Portion of the Wine Aroma Wheel.

Like similar tools,[31] the Wheel is also an *objectivity engine*. As used by people wanting to structure their sensory experience and to communicate with others, the Wheel may be supplemented by a series of physical reference samples: 'The fastest training method', according to the proprietary website, 'is to make physical standards to illustrate important and major notes in wine aroma'.[32] If, for example, people need to remind themselves of an asparagus odor, they are advised to open a tin of asparagus and to put a few drops of the liquid in a 'neutral white wine'. Similarly, a peach aroma is referenced by several teaspoons of peach (or apricot) purée in the wine carrier. In light of the Davis research program from which the Aroma Wheel emerged, it is worth noting that at the time of the Wheel's inception just a few of the terminal descriptive terms referred to naturally occurring substances for which the odor-causing molecule had already been established. While these descriptors gave confidence that the relevant subjective experience had a known objective cause, there was no evident intention to replace vernacular with chemical terms: 'bell pepper' *could* have been replaced by 2-methoxy-3-isobutylpyrazine, but, presumably for practical purposes, was not. Yet one arc of the Aroma Wheel was chemical all the way through. It was considered plausible to ask people whether they reckoned that a wine had a 'chemical' aroma, and, if they did think so, then, by the time they reached the terminal vocabulary, their choices might, in some cases, be the names of chemicals considered familiar – 'kerosene' ('petrol'?), 'diesel', 'hydrogen sulfide', 'sulfur dioxide', 'acetic acid'. And, if people judged a wine to have a primary 'caramel' odor, they might wind up with a terminal descriptive term that gave them the choice of saying that a wine smelled of 'diacetyl' or that it had a 'buttery' odor.

The Aroma Wheel is one outcome of the program in sensory evaluation launched at Davis from the 1950s. Yet, it is a hybrid artifact. It aims to stabilize subjective

experiences and reports on those experiences, and, in the sense repeatedly deployed by Amerine and his colleagues, to render them objective. Confidence in this objectivity is underpinned by chemical science but it is extended into domains chemistry had not, and has not, yet reached. For instance, it is not now securely known what, if any, odorant is characteristic of both tobacco, a commonly used wine odor term, and certain sorts of red wine. And there has developed among some wine experts a degree of skepticism about whether secure causal relations of the sort represented by the green pepper-pyrazine link are now typical or ever will be common. The sensory effects of different concentrations of the same substance, the consequences of substance–substance interactions and ineliminable contextual effects on the experience of odor, they consider, make it unlikely that we will *ever* arrive at a descriptive vocabulary in which most, or even many, specific subjective experiences will be causally linked to specific known volatile chemicals (Robinson et al., 2014).

At the same time, the language represented by the Aroma Wheel, and encouraged by the program of sensory evaluation, has had significant effects in how consumers, as well as wine experts, have now come to talk about the organoleptic characteristics of wine – and, indeed, of many other products on the market (foods, beer, whiskey, coffee, tea, perfume, soaps, room fresheners, new cars, and so on). In 1960, the American Society for Testing and Materials (ASTM) set up its Committee E-18 on Sensory Evaluation to develop appropriate industrial standards, and similar functions are performed by the International Organization for Standardization (ISO) in categorizing and measuring odors and tastes (Peyram, 1990).[33]

Consequences: Judgment, science, and the global market

Although wine consumers were not the targets, or at least not the main targets, for the sensory reforms initiated by Amerine and his colleagues, the language of sensory evaluation and the accompanying search for objectivity eventually led to a fundamental change in how wine drinkers, wine writers, and wine marketers came to talk about sensory experiences, and, arguably, in how they orient to, categorize, and *have* such experiences. The analytic vocabulary of odor components has, since the 1970s, become routine in the wine world. Before that time, 'wine tasting' books offered instructions on securing the correct equipment (glasses, decanters), on proper gestures (swirling the wine, positioning the nose with respect to the glass, cleansing the palate, etc.), and on the arrangement of contextual circumstances (notably ambient temperature), but rarely had much to say about the odors of specific wines.[34] It was only from about the mid-1970s that popular books on wine tasting offered a focused orientation to the discrete aspects of odor. This vocabulary is now widely used by winemakers and wine writers in their attempts to tell consumers what particular wines are like and how one is different from another. This information is of special importance in Anglophone settings where all the world's wines may be available in supermarkets and where consumers cannot be presumed to have much or any experience with the sensory profiles of many of these wines. The vocabulary of wine odors that emerged from the middle of the 20th century is an index of globalization. Wine is a consumer product that is no longer necessarily associated with wine-growing cultures: You cannot intelligibly tell an American or a Chinese consumer

that this Chablis is 'typical' if they do not know what Chablis is typically like.[35] Analytical language can help repair that lack of familiarity, just as it can signal objectivity by linking analytic descriptions to expertly established real properties of wine as an object.

Wine is a consumer product, and, just like the products reviewed and evaluated in *Consumer Reports* or *Which?*, it is increasingly analyzed into its component real properties and then those component properties are re-assembled into some objective-seeming overall index of 'value for money' or 'quality-price ratio'. The outcome is identified as an antidote to the advertisers' and marketers' attempts to sell you something that they say is better than it really is. This is where analytic descriptors join as marketplace conventions with the more widely commented-on numerical assessment of wine quality. Describing a wine as having the odors of white peaches and guavas is intended as an objective way of communicating its organoleptic properties, while assigning it a score of '91' is intended as an objective way of communicating how good it is.[36]

Amerine almost certainly did not intend his objectification of wine talk to escape from the enological laboratory or the world of professional judges to the mass market, but it eventually did. His work, and that of his associates, has a legacy in the present-day wine world and in other practices that involve talking about the sensory experience of commercial products. It is now routine to describe wines (and some other food products) through their component odors (or what are said to be those components), often in terms as specific and apparently exotic as 'wet stones', 'apricot kernels', 'savory herbs', 'tomato skins', 'sweaty saddles', 'crushed raspberries', and 'roasted lilacs'. And that sort of language itself is now widely regarded as fanciful, just as pretentious and arbitrarily subjective as the allusive and evocative vocabulary – 'elegant', 'nervous', 'masculine', and 'feminine' – it historically replaced. Some wine professionals, especially among Old School Europeans, consider such analytic specificity to be impossible and ridiculous (Peynaud, 1987 [1983]: 192–193; Shapin, 2012b: 51–53). But one consideration that attracts adherents is the stated intention to describe what a wine, in its sensory aspects, *is really like*, as opposed to what aesthetic resonances it may *evoke*, what it makes you *feel* like, in what precise circumstances and company you consumed it, and what marketers and advertising agencies may say it is like. It's a long way from the Amerine's list of permissible descriptors, or even Noble's Wine Aroma Wheel, to finding the odor of 'roasted lilacs' in a Beaujolais, but the historical path to this sort of language was informed not by poetic allusions and undisciplined subjectivity but by systematic attempts to ground sensory experience and sensory reports in hard scientific discipline.

This account of some passages of wine research may also help to recognize trends that increasingly characterize much late modern science. I've mentioned here two considerations that have come significantly to bear upon the accomplishment of practical objectivity: personal judgment (or taste) and the market. When goods are produced for the market, their success or failure depends upon the judgment of people who may or may not purchase them, who may or may not describe and recommend them to other people. The producers and sellers of these goods typically want to understand consumer judgment, how it is formed, how to communicate to consumers, and how consumers communicate with each other. That is to say, producers and marketers want objective knowledge of subjective reactions and judgments. Subjectivity here appears very 'hard', after all. Many producers of commercial goods and services do seek to change

consumers' subjective judgments, but one thing they cannot do is treat such subjectivities as *wrong*. Consumer judgments are quite durable facts of the matter: There is a sense in which markets posit consumers who *are* 'always right', in which consumers' assessments count as objective. A great deal of late modern science – both natural science and human science – is now enfolded within market concerns. We are now well familiar with ways in which it's plausibly said that the market distorts scientific objectivity. We might also be interested in how commercial concerns turn the subjective qualities of personal preference into forms of objectivity. That's what markets try to do, and that's what they sometimes succeed in doing.

Acknowledgements

Several references here are made to typescript and manuscript material in the Papers of Maynard Amerine, held in the Special Collections of the University of California, Davis. Some of the published material cited here is rare and copies in the Amerine Papers may be, for these, the most accessible, or only, source. This collection was about to be re-cataloged at the time I consulted it, and occasional references to box numbers is to the arrangement current in February 2015. I thank the Davis Special Collections staff (Liz Phillips, Daryl Morrison, and Axel Borg) for their assistance in using these materials, and Professors Hildegard Heymann and Ann C. Noble for answering a number of my questions about Davis traditions of work in sensory evaluation. I thank Christopher Phillips of Carnegie Mellon University for many constructively critical comments on earlier drafts of this paper.

Notes

1. Well-known historical treatments of objectivity as changing modes and as performances include Daston and Galison (2007) and Poovey (1998); see also Shapin (2012a).
2. Turning subjective qualities into objective qualities has been a leading concern of the historian of modern human sciences Rebecca Lemov (2015: 36–38, 143–144).
3. Concern with the professional authority of enologists is evident in a typescript titled 'The Educated Enologist' (in Box MSS [1] of the Amerine Papers at University of California (UC), Davis), probably a draft for Amerine (1951), and in Amerine (1959a). For correspondence with the winemaker Martin Ray, see letters of 12, 19, 23 October 1959 (Box MSS [14]), and also 'Tasting as a Means of Improving Wines' (typescript dated 13 May 1957): Box MSS (3). For expertise and the tasting abilities of average US consumers, see 'Wine Tasting' (typescript dated 1938); 'Some Comments on Wine in America' (typescript dated 1942) in Box MSS (1); 'What the Public Likes' (typescript dated 1958), in Box MSS (3); Baker et al. (1960: 813), where contemporary consumer preference testing was dismissed as a 'turbid mess'; and Amerine (1964a).
4. A register of Amerine's writings (and those of his co-workers) is contained in Amerine and Phaff (1986: 6–23); see the index for publications in which Amerine was not the first-named author.
5. Axel E. Borg, 'Maynard A. Amerine': http://www.lib.ucdavis.edu/dept/bioag/collections/vitic/amerine.php (accessed 7 December 2015).
6. See Ebeler and Thorngate (2009), and for a fine historical treatment of French enology from the late 19th to the mid-20th century, see Paul (1996: chapters 10–12).
7. For example, Henderson (1824: 135–136) and Prout (1812: 457, 460) (for two of the earliest such distinctions). For modern usages, see, among many examples, Crocker (1945: 4–6, 32–34), Amerine and Roessler (1952: 97), Bakker and Clarke (2012: 3–4, 89, 239, 249, 261), Jackson (2002: 11–12), and Amerine and Roessler (1976: 70, 123, 198). A definition of flavor

is even available from the International Organization for Standardization (ISO): 'Complex combination of the olfactory, gustatory and trigeminal [nerve] sensations perceived during tasting. The flavor may be influenced by tactile, thermal, painful and/or kinaesthetic effects' (Delwiche, 2004: 137).

8. Neuropsychologists often use the term 'synesthesia' to designate rare conditions in which an individual might, for example, 'see' letters as colors, while flavor researchers generally use it to refer to multi-modal experience in general: see Auvray and Spence (2008) and also Perullo (2016).
9. For example, Liebig (1859 [1843]: 217); also Thudichum and Dupré (1872: 220–221), Grazzi-Soncini (1892: 6n), and Jackson (2008: 271).
10. For 19th-century pessimism about the possible powers of a science of odors, see Guyot (1865 [1860]: 98) and Henderson (1824: 132).
11. A revised and enlarged edition was published by the University of California Press in 1983, but it is to the first edition that I refer. Most references below to work jointly published with Roessler are identified here with Amerine's views, as the division of labor seems clear, with Amerine responsible for enological matters and Roessler taking the lead in the extensive statistical portions treated in Phillips (2016). For historical background to sensory science and sensory evaluation, see Lahne (2016), which the author brought to my attention after this piece was written.
12. For philosophical engagement with wine objectivity and subjectivity, see Smith (2007: esp. chapters by Smith, Deroy, and Origgi).
13. There are some loose references to empiricism and the philosophy of George Berkeley in Amerine (1958), as well as recognition that 'all sensory tests', however rigorously designed, must be subjective.
14. Systematic efforts at achieving objectivity in sensory evaluation of wine took hold very strongly in the United States, and were sometimes treated with bemused skepticism in Europe, but they were not unknown in France: see, for example, Pusais and Chabanon (1974 [1969]: esp. 29).
15. See Shapin (2012a: 172–176) for discussion of the taste-judgment distinction in 18th-century aesthetics and in the work of Thomas Kuhn.
16. The best existing linguistic treatment of wine is Lehrer (2009 [1983]), to which all subsequent work, including this, is indebted. Although her work is partly experimental, and while she does not follow the story far into the domain of chemistry, intermittent reference to Lehrer's work in what follows doesn't adequately reflect the extent to which she has contributed to appreciating the broader significance of wine language. For a highly pertinent study of objectifying practices in coffee-tasting (to which my attention was drawn after this article was completed), see Liberman (2013), and for fine work on the experiences, practices, and nature of taste, see Hennion (2007), Hennion and Teil (2004), Teil and Hennion (2004), Teil (2001, 2009), and Perullo (2016).
17. The Davis scoring system was periodically contested by advocates of other systems and it was continually revised to make it more reliable and purportedly objective. It was originally a method of rating California 'experimental wines', where standards of typical goodness had not yet been established, and, while it was an aspect of sensory evaluation by naïve subjects, it was used by 'experienced judges' at Davis, who had employed it 'without serious difficulty'. Amerine and Roessler complained about its use (or 'misuse') by amateurs (Amerine and Roessler, 1976: 122–124).
18. The cartoon has been widely reproduced, originally appearing in the *New Yorker* for 27 March 1937: 23.
19. There were precedents for a permissible/impermissible glossary of wine taste and odor terms, notably Broadbent (1968), though Broadbent's British vocabulary was much more spare than Amerine's.
20. French experts were less dismissive of such metaphorical language: see, notably, Peynaud (1987 [1983]: 180–182). See also Amerine (1966c: 1626) and the letter from Peter M. Neely

(a University of Kansas biologist) to Amerine, 28 January 1977, in Amerine Papers, Box MSS [21]) for his awareness, and disapproval, of French foot-dragging in adopting sensory evaluation on the American model.

21. Anonymous (1836–1837, 1857–1858: 361–363) and Liebig (1840: 289, 1859 [1843]: 217).
22. Œnanthine was at the time believed to be a distinct molecule, though by the early 20th century it was characterized as a mixture of compounds – higher fatty acids and their ethers. However, as late as the 1960s, Amerine's survey of organic constituents in wine still made reference to the probable presence of œnanthic acid (Amerine, 1964b: 462). Some of Amerine's earlier work pointed to lauric acid – in low concentrations – contributing a 'vinous odor' to wines: Amerine (1953: 254), Amerine et al. (1959: 499–500); see also Amerine (1964b: 463) and Amerine and Roessler (1976: 196).
23. The reference here is to French research: Bayonove et al. (1975). The original green pepper work, using a simultaneous distillation-extraction technique, was reported by Buttery et al. (1969); see also Heymann et al. (1986).
24. Professor Hildegarde Heymann (UC Davis), 8 July 2015, personal communication. Cornelius S. Ough (b. 1925) was, in the early 1950s, Amerine's technician and, from 1971 until Amerine's retirement, his professorial colleague; see also a 1989 interview with Ough about his career: http://digitalassets.lib.berkeley.edu/roho/ucb/text/ough_cornelius.pdf (accessed 7 December 2015).
25. The development of flavor research by the US Army Quartermaster Corps and Arthur D. Little is being treated in a PhD thesis by Nadia Berenstein (2016).
26. Interview with Cornelius Ough: http://digitalassets.lib.berkeley.edu/roho/ucb/text/ough_cornelius.pdf, esp. p. 11 (for the introduction of gas chromatography; accessed 8 December 2015).
27. Lehrer (2009 [1983]: 187–188). Available at: http://chemwiki.ucdavis.edu/Analytical_Chemistry/Instrumental_Analysis/Chromatography/Gas_Chromatography#Photoionization_Detectors (accessed 8 December 2015).
28. In the early years of gas chromatography, it was recognized that the human nose might, in certain cases, be a vastly more sensitive detecting instrument (Harper et al., 1968: 56–57).
29. See also http://www.intowine.com/qa-ann-noble-inventor-aroma-wheel (accessed 8 December 2015). For the prior history of attempts to standardize the vocabulary of odor, see Harper et al. (1968: 81–87).
30. Images of the Wine Aroma Wheel are widely available on the Web; this image is a portion of the one at http://www.thewinecellarinsider.com/wine-topics/wine-educational-questions/davis-aroma-wheel/ (accessed 8 December 2015). The device itself can be purchased at http://winearomawheel.com/ (accessed 29 April 2016).
31. See, for example, the French-developed kit marketed as Le Nez du Vin: http://www.winearomas.com/?gclid=CPvVkdm91cUCFdSQHwod4bQAzQ (accessed 8 December 2015).
32. http://winearomawheel.com/how-to-use-it (accessed 8 December 2015).
33. See also http://www.iso.org/iso/catalogue_detail.htm?csnumber=36791 (accessed 8 December 2015).
34. For examples of popular advice on 'tasting' understood as instruction on different sorts of wine and as a prescribed set of gestures and conditions, see, among many examples, Brown (1830: 260–276), Redding (1839: viii–xiv), Shaw (1864: 43–44, 50–51), and Haraszthy (1889: 47–80).
35. In the late 1950s, Amerine and a Davis co-worker found it sensible to write in a professional enology periodical that 'The predominant odor for the Cabernet wine [is] a Cabernet aroma …' (Ough and Amerine, 1959: 19).
36. The leading American figure in these tendencies has been the lawyer-turned-leading-wine-critic, Robert M. Parker, Jr, who has explicitly likened himself to the consumer-advocate Ralph Nader: Parker (2008: 4–5, 1997: 19); see also McCoy (2005: 66–67) and Shapin (2005, 2012b: 85–86).

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