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Same Compounds: Different Flavours?

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Abstract

We can explain the different tastes of two wines by the differences in their compounds. However, we cannot explain what a wine tastes like solely in terms of its chemical compounds. The same active compounds can affect individual tasters quite differently because of differences in their thresholds of perception. Moreover, the effects of different compounds on our senses can give rise to cross-modal interactions where sensations of, say, sweetness, can be enhanced by a vanilla aroma without a corresponding increase in the wine's sugar levels. This makes it difficult to relate the micro-chemical composition of a wine to the perception of its tastes or flavours. However, we can achieve a better understanding of the relation between a wine's compounds and its taste profile once we recognize the dynamic and cross-modal nature of taste perception. The full story of the impact of certain compounds on tasters will have to take account of the cross-modal influence one sense has on another. I will illustrate the sort of account that is needed by reference to recent findings in perceptual psychology and cognitive neuroscience.

1. *Introduction*

Perceptible differences in the tastes of two wine samples can often be explained by the difference in chemical compounds, or behaviour of those compounds, in the two wines sampled. A young and tannic red wine will not be perceived in the same way as a sample of the same wine after considerable aging. The reason is that when the polyphenols polymerize with time they form longer and longer chains until, being too heavy, they sink to the bottom of the bottle as sediment, leaving the wine lighter and rendering it softer and less astringent to the taster.

We can even explain the difference in effect on the taster. The tannins coagulate the proteins in the saliva, leaving the surfaces of the mouth and tongue less slippery. In cases like these, the processes at work in the wine, and in interaction with the taster, can explain the taster's perceptual experience. However, we seem at a loss to explain how a wine will taste simply on the basis of its chemical composition. What we have

on the one hand is a detailed description of the compounds that make up the wine and on the other the individual subjective responses of tasters. The latter seem too variable, too fleeting, and too subjective to allow us to bridge the gap from the chemical composition of the wine to the perceptual experience of tasters. And yet it is hard to shake the conviction that it must be the micro-elements of a wine that are responsible for how it tastes. The puzzle is to understand how we can hold on to this conviction in the face of the gulf between a wine's chemical make-up and the perception of its taste.

2. *Compounds, Flavours and Perceptions*

Progress can be made by recognizing that not all subjective responses tasters have to a wine are equally valid. Poor health on the part of the taster, immediately previous tasting history, and even mood, can all have an adverse effect on one's ability to perceive the taste of a wine. Thus we should not expect every aspect of a taster's subjective response to be laid at the door of the wine tasted. Here it is important to leave room for the distinction between a wine's taste and our perception of its taste. Something frequently missed by many wine writers.

With this distinction in mind, we can try to bridge the gulf between a wine's compounds and the experience of tasters by making room for *flavours* seen as both properties of a wine and that which is perceived by human tasters. As we shall see, flavours incorporate elements of taste, touch, smell, and perhaps vision, but are commonly described and thought of as 'how the wine tastes'. Flavours have a complexity that makes their reduction to absolute levels of particular sapid or odorous substances in a wine impossible; i.e. the route back from a flavour to its chemical composition is not always traceable. However, if flavours are to serve as a bridge between the wine's chemistry and the experiences of tasters, they must depend on the chemical components of the wine in a well-behaved way. A potential threat to any such strict dependence is the possibility of the same wine's active compounds giving rise to different flavours. Is this possible?

In what follows I shall explore two prima facie cases, but argue that we need not interpret then as counter-examples to the law-like dependence of a wine's flavours on its chemical composition. The two cases concern radically different perceptions of flavour by novice and expert wine tasters, and divergence in perceptions of flavour among expert tasters.

3. *Defining and Delimiting Flavours: multisensory integration and interaction*

Flavour is a perceptual category: flavours are what tasters perceive in foods or wines. But to describe them as perceptual categories is not to suppose they are just psychological constructs (pace Prescott 1999). We can think of *chair* as a perceptual category depending on our way of grouping objects in the world, with no other way to define the similarities among all those things we call chairs; which does not make them any less real as physical objects.[1]

[1] Chairs may not be recognised as a category by other animals, and the concept of a chair is not a concept recognised in fundamental physics.

Many senses are deployed in the perception of a wine's flavour. Vision, audition, olfaction, gustation, the somatosensory and haptic system and the trigeminal system can all be recruited when tasting wine, and the resulting perceptual experience can be seen as involving the modulation, interaction and integration of information from these different sensory modalities.(Auvray and Spence 2007, Bult, Wijk and Hummel 2007) Such cross-modal interactions occur at early stages in perceptual processing with the enhancement or inhibition of a response in one sensory modality as a result of activity in another.

It is firmly established that odours of vanilla or strawberry can enhance the intensity of sweetness tasted in a sucrose solution, without any chemical change to the solution. Equally, tastes can enhance odour intensity. (Frank and Byrnam 1988, Cliff &Noble 1990, Prescott et al. 1996, Stevenson, Prescott & Boakes 1999, Dalton et al 2000) Prescott et al. (1996) suggest that such cross-modal effects show not only that a 'sweet'-smell can produce enhancement of a taste of sweetness, but that in suppressing tasted sourness, the sweet odour functions in the way a sweet taste would.

Texture, taste and smell also interact in determinate ways in tasting foods or wines, and these cross-modal interactions 'are the rule not the exception' (Auvray and Spence 2007). Perceived flavour intensity is reduced as a result of increased viscosity of the tasted substance without changing the sapid or volatile components of the substance, while an odour stimulus presented retronasally can increase the perceived intensity of thickness or creaminess of a substance. (Bult, Wijk, Hummel 2007) Temperature, registered by the trigeminal nerve can also play a part in the perceived flavour of a wine (Delwiche 2004). At lower temperatures perceived bitterness and acidity are boosted.

Such early modulation of one sensory modality by another, such as vision on olfaction, or olfaction on taste, can have *superadditive* effects. This is demonstrated by a sub-threshold odour compound being more easily detected when presented with a sub-threshold taste compound than when presented alone. This effect is found only where the odour and taste qualities are congruent. E.g. a 'sweet' odour of strawberry or carmel presented with a sweet taste, such as sucrose. (Delwiche and Heffelfinger 2005, Dalton et al 2000)

The effect of visual clues on the use odour terms has been demonstrated by a well-known experiment by Morrot, Brochet and Dubourdieu (2001) where subjects use red wine terms to describe the odours of a white wine coloured with a tasteless food dye. Taste intensity also increases as the depth of colour increases.

The neural correlates of these cross-modal interactions are gradually becoming better understood with the help of fMRI, EEG and MEG techniques, and these results suggest that modulations of one sense modality by another at low levels of perceptual processing are not simply the result of co-occurrence of different sensory responses. Cerf-Ducastel et al.(2001) showed that taste stimuli sensed by the tongue together with somatosensory stimuli from the mouth, despite their different modalities can activate common cortical areas. The result of the interactions of information from these different sensory receptors is the formation of unitary flavour percepts that integrate this information. Prescott (1999) and Auvray and Spence

(2007) see this as a form of Gibsonian 'direct perception' of ecologically valid features of the external environment. (Gibson 1966)

Flavour is defined here as a perceptual category, nevertheless, we need to keep in mind the distinction between flavour and the perception of flavour. For as we shall see, factors internal and external to the subject can influence flavour perception, and we should not be willing to conclude that the perception of flavour is accurate under all conditions. So although flavours are defined in terms of interactions between the volatile, sapid and tactile components of a substance *and* the taster, it is important to delimit the extent of the underlying substance base for the flavours we perceive. When drinking a young, tannic wine while eating white fish one is likely to perceive the wine as having a metallic taste. (This being the only reason for the conventional prohibition of drinking red wine with fish!) Similarly, when one eats red meat and thereby introduces more protein into the mouth the effects of the coagulation of proteins by the wine's tannins will be lessened and the wine will be perceived as less astringent. However, these external influences introduce additional chemical effects and should not be included among the flavours perceived for a particular wine. Not every perception of flavour the wine gives rise to under all conditions count as presenting the flavours the wine has. These additionally perceived flavours are not getting at qualities of the wine and hence such variations from one occasion of tasting to another can be discounted.

However, there are variations among the perceptions of tasters that seem to concern the taste and aroma qualities of the wine itself, and these need to be addressed if we are to avoid the conclusion that differences in flavour can be due to something other than the soluble and volatile components of the wine. This conclusion has to be avoided if we are to deny that the same wine compounds can have different flavours for different perceivers.

4. *Flavour Differences between Novices and Experts*

The relevant cases concern differences in flavours perceived by novice and expert wine tasters, and differences among expert tasters. People commonly conflate odours and tastes, and they are wiling to describe certain aromas as sweet-smelling. Prescott (1999) argues that 'sweet' may be a flavour where the division into a taste and smell is more artificial than real. At any rate, where odour-taste pairs are congruent there is more likely to be a fusion of the two into a single percept. The multisensory integration of sensory information as opposed to mere cross-modal interaction, such as the well-attested enhancement of the taste of sweetness by 'sweet-smelling' vanilla odour suggests a loss of information and perceptual discrimination. However, the novice may be more likely to confuse or fuse odour-taste pairs into a single perceptual experience, while the expert may retain the ability to discriminate each member of the pair. The expert will, however, in the normal course of things, still be subject to taste enhancement effects for congruent taste-odour pairs.

Should this difference between the two components of flavour perceptually discriminable by the expert, and the single component replacing both of them that the novice perceives, lead us to say that a wine has *different flavours* for the novice and for the expert? Not necessarily. For we should distinguish genuine fusion where

sensory information from two or more sense modalities is integrated in early processing and cannot be distinguished, from cases of cross-modal interactions or modulations where we can learn to separate the components and attend to them separately. At first, novices will not treat properties of taste, touch and olfaction separately in a single act of tasting, but through training in the techniques of analytical tasting, they may be able to attend differentially to these separate flavour components. Thus, we need not say that the wine has different flavours for novice and expert but rather that the flavours of wine are perceived differently. The proper conclusion is that *how* we taste affects *what* we can taste.

By adopting different perceptual strategies we can affect which flavours we are able to perceive. Here we can invoke McBurney's (1986) distinction between analytic and synthetic perception of flavour. Analytic perception is where two stimuli mixed in a solution keep their separate identities and individual qualities. Synthetic perception occurs when the two stimuli mixed together lose their individual qualities of sensation and are replaced by a third, distinct sensation. Prescott points out that different task demands can encourage subjects to adopt different perceptual strategies, either analytic or synthetic, leading to different perceptions of flavour. (This may be done by offering them different rating scales, however this is not to suggest along with Clarke and Lawless 1994 that the interaction effects are the result of 'halo dumping', where subjects transfer some of the intensity rating to the only available scale offered for rating.)

Subjects will form different perceptions of flavours by perceiving either analytically or synthetically. Results from psychophysics and cognitive neuroscience confirm that the enhancement of taste sweetness for a solution goes away when subjects are asked to rate for fruitiness or sourness instead of sweetness. This does not mean that only perceptions resulting from analytical perceiving present the real flavours of the wine. The normal cases of enhancing taste sweetness by odour and vice-versa, along with cross-modal interactions between vision and olfaction, the somatosensory, haptic and trigeminal systems on gustation and restronasal olfaction, are also good guides to a wine's flavours. The case of multisensory integration into a overall flavour percept, or synthetic whole, can also present us with knowledge of the flavours of a wine, and as perceptual experiences they are good guides to the overall impression of the complexity, balance and harmony of a wine — these being crucial features of a wine's quality.

5. *Synthetic Perception of wholes with Analytic Awareness of Components?*

To avoid choosing either analytical or synthetic perceiving as the most accurate reflection of a wine's flavours we must turn to the suggestion of Haplern (1997) that the two perceptual strategies are not mutually exclusive, and can with training be combined. Thus skilled tasters learn to perceive the overall impression of the wine as a whole with a flavour profile that includes its dynamic time course, necessary for the perception of the resolution of competing flavours in the finish, as often happens with complex yet balanced wines. According to this suggestion, the difference between the novice and the expert taster does not amount simply to the difference between synthetic and analytic perception of flavour, but is due rather to a gradual move, first from synthetic wholes to the recognition of the component parts of the wine's

flavours as a result of analytical perception until a point is reached where one has the experience of synthetic perception while retaining the ability to discriminate and attend analytically to distinct flavour components. (The closest analogy would be listening to a symphony as a unified musical experience while attending to particular instruments or notes). It is in reaching this stage that the expert is distinguished from the novice. This certainly reflects the practice of experienced wine critics who try to describe the distinctive components of a wine while giving some impression of the overall experience of tasting it.

6. *Residual Differences in Flavour Perception*

One last case remains to be examined, where expert critics or wine professionals diverge or disagree about their perception of the same wine. Is this a case of a wine with the same chemical compounds gives rise to different flavours? Assuming both tasters are experienced and neither is prone to perceptual error in such a case, what should we make of their disagreement and of the relation between a wine's flavours and its underlying chemical components?

Here again, the findings of cognitive neuroscience have import for what we should say. In particular, selective attention to particular tastes, odours, or textures can have inhibitory effects on our sensory responses in other sense modalities, thereby extinguishing the normal enhancement effects and affecting the overall perception of a wine's flavour. (Prescott et. al. 2004) This may mean that critics or wine professionals can, while attending to some component of flavour, miss others, or be differently perceptually placed at the time from others as a result of their slightly different attention or allocation of resources. To be over-attentive to one quality may make it difficult to switch back and forth from analytical to synthetic perception of the wine. Once again, the proper conclusion should be that *how* we taste affects *what* we can taste, and the flavours we can perceive. Seen in this way, such cases of different perceptions offer no threat to the proposed dependence of a wine's flavour on its underlying chemical composition. However the dependence in question will not amount to a full reduction. The multisensory intergration that leads to flavour perception, along with various cross-modal interactions and modulations of one sensory response by another cannot be captured at the underlying level of chemical compounds without reference to the human taster. Moreover, the perceptual signal of a particular chemical component is not always easily identified in such complex compounds. The compound diacetyl in white wines may be responsible for their buttery flavour, terpenes may taste citrus-like, looking at things from the other side, an aroma does not always have an unambiguous signal. The smell of vanilla that gives rise to enhancement of the taste of sweetness may be due to vanillin from the oak barrels the wine has been kept in, but it may equally be due to vanillic acid that occurs in wines kept in stainless steel tanks (Deroy 2007). Flavour components will depend on underlying wine chemistry but cannot always be placed in a one to one correspondence with groups of molecules. Attention to the taster and the neuroscience of flavour perception will still play a crucial role in bridging the gap between chemistry and flavour.

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