
BARRY C. SMITH

Institute of Philosophy, School of Advanced Study, University of London

Barry.Smith@sas.ac.uk

THE NATURE OF SENSORY EXPERIENCE: THE CASE OF TASTE AND TASTING

abstract

Recently, psychologists and neuroscientists have provided a great deal of evidence showing that perceptual experiences are mostly multimodal. As perceivers, we don't usually recognize them as such. We think of the experiences we are having as either visual, or auditory or tactile, not realising that they often arise from the fusion of different sensory inputs. The experience of tasting something is one such case. What we call 'taste' is the result of the multisensory integration of touch taste and smell. These unified flavour experiences provide a challenge when trying to reconcile the underlying processing story with the conscious experience of subjects, but they also challenge assumptions about our access to our own experiences and whether how we conceive of those experiences plays any in role in accounting for their ultimate nature.

keywords

Multisensory, flavour, taste, smell

1.
Sensory
Experience

Our most fundamental contact with the world comes through our senses. They inform us about our immediate surroundings and our embodied selves. But as many philosophers have pointed out, they can also mislead and distort. The unreliability of the senses convinced the Rationalist philosopher Rene Descartes that they could not provide a firm basis for our knowledge of the external world. Instead, he thought a purely rational faculty was necessary to provide us with knowledge of reality. By contrast, the Empiricists believed that the contents of the mind were all derived from the senses, and taking this position to its ultimate end, David Hume adopted a thoroughgoing agnosticism about the causes of our sensory impressions. Working from within experience, he argued that there was no standpoint from which to compare items before the mind with things in the outer world; so anything we said about that outer realm would be mere speculation.

In accepting this epistemological gap between the mind and the world, Rationalists and Empiricists both took for granted that we had immediate knowledge of how our senses presented things to us; i.e. of how they appeared in the light of our senses. But for different reasons, they both thought that such sensory experiences could not provide a sufficient basis on which to conclude anything about the external realm. The distinction invoked here between appearance and reality coincided with the divide between mind and world, and although we could not be certain of how things were in reality, we could, on the basis of experience alone, be certain of how things appeared to us. Experience, was taken to be knowable through and through, and was, in effect, just a matter of things appearing a certain way to us as subjects. The philosophical task was to find a way to cross the divide between how experience presented things to us and how they really were; a task that Hume subsequently abandoned. However, both Descartes and Hume assumed that we had immediate knowledge of how things were in our experience, despite Descartes' method of doubt where he questioned everything that he had previously taken for granted.

It is the assumption that we can straightforwardly recognize how things are in our experience that I want to question. This is not because of the direct Realist's claim that appearances that present things as they are and those in which are just appearances are sometimes indistinguishable by subjects.

Instead, the case I am interested in is where aspects of our experience go missing in how things appear to us; i.e., a case where there are properties of our experience that we fail at first, to recognise. This is to suggest that an appearance-reality distinction operates within experience itself. To some, this will sound unintelligible. Surely, things appearing a certain way to a subject just is what it is for that subject to have a conscious experience. There is simply no room for a gap between appearance and reality within experience. And since the senses shape our perceptual experiences, we are bound to know their sensory character; i.e., they are either cases of seeing, hearing, smelling, touching or tasting.

This view, I will argue, is utterly mistaken. We can be misled by, and about, our perceptual experiences and can fail to recognise the senses we are exercising when having those experiences, as recent work on the senses in psychology and neuroscience shows. How things appear to us *within* experience is not always how they are. I will illustrate this general point by considering the case I know best: that involving tastes and tasting.

2. Acts of Tasting

Eating, or sipping something, will produce a distinctive experience in the mouth. These are fleeting experiences, quickly over and done with, that are hard to concentrate on but which leave us with an immediate hedonic reaction, of liking or disliking. What really goes on in tasting experiences, and what do they provide us with experiences of? These are the key question, and as we shall see later, liking and disliking are important distractors.

When tasting we think we are getting most of our information from the tongue. But in fact very little comes from there. Receptor firings on the tongue code for 'basic tastes' such as salt, sweet, sour, bitter, savoury, metallic. And yet these gustatory properties don't exhaust what we are capable of tasting. Think of tasting 'ripe mangoes, fresh figs, lemon, canteloupe melon, raspberries, coconut, green olives, ripe persimmon, onion, caraway, parsnip, peppermint, aniseed, cinnamon, fresh salmon' (Sibley 2006, p. 216). We don't have receptors for melon or onion, or any of these other things. These are not tastes: they are *flavours* and our ability to experience them depends on more than taste alone. Notice, that we cannot construct such flavours from combination of basic tastes alone. As Frank Sibley put it:

Coconut may be somewhat sweet, and lemon sour or acid, but what other tastes combine with sweetness to give coconut, or with sourness or acidity

to give lemon? How could one construct a blend of distinguishable tastes...to yield that of coconut, or lemon, or mint? Try to imagine a recipe: 'To make the flavour of onion (or pepper, or raspberries, or olives), add the following [basic tastes] in the following proportions . . . ' (Sibley 2006, pp. 216-7).

There is no such procedure. However, the act of tasting gives us knowledge of these easily identifiable flavours. So the objects of perception in tasting are not *tastes*, but *flavours*. Tastes proper are only a part of what contributes to our experience of tasting something. Taste exclusively concerns the gustatory dimension of flavour perception: it is the upshot of taste receptors firing in the oral cavity, on the tongue and in the gut.

In fact, the sensations that the tongue produces - gustatory sensations - are hard to experience alone save in experimental settings, for example, when drops are put on parts of an anaesthetized tongue and we prevent any other sensations, of smell say, from contributing to the subject's experience. So what we call 'taste' is not just sensations from the tongue but the perception of flavour, and even what we think of as experiences of the so-called basic tastes, like sweet, sour, salty, etc. may, in fact, be experiences of flavours. (See Spence, Auvray and Smith 2013). But what are flavours and how do we perceive them?

3. Taste and Flavour

Let's start by asking how tasting produces experiences that provide knowledge of flavours:

Although the experience of the sensory qualities of a food are often described in terms of how it "tastes", in practice this experience of flavour is a complex interaction (Yeomans et al. 2008)

It is in effect, a multi-sensory product: a fusion (confusion?) of different inputs. Yet, the seemingly unified experience of flavour gives us little clue that it is a complex interaction effect, which may be why we think of it as just taste. The missing element, along with taste, that contributes to the experience of flavour is smell. But it is easy to miss this when thinking of smell as we ordinarily do, as the sniffing of odours in the environment. This is *orthonasal* olfaction: the inhaling of odours from our surroundings. But we need to follow Paul Rozin in distinguishing two senses of smell: *orthonasal* olfaction and *retronasal* olfaction (Rozin 1982).

An odour molecule may reach the olfactory epithelium in the nose (orthonasal olfaction) or the mouth (retronasal olfaction). When an odour is sensed orthonasally, it is perceived as originating from the external world. In contrast, when an odour is sensed retronasally, it is perceived as [arising] from the mouth (Murphy et al. 1977; Rozin 1982) quoted in Small et al. 2005, p. 593.

Orthonasal olfaction allows us to detect environmental stimuli: predators, smoke, food, or mates. *Retronasal olfaction* allows us assess what we have just swallowed, letting us know whether to reject it or continue eating.

With orthonasal and retronasal olfaction, 'the same receptors in the olfactory epithelium are activated but depending on the direction of flow of odours they project to different cortical areas' (Small et al. 2005). This can result in different conscious experiences of the same odours. When airflow is from the mouth to the nose, we tend to get 'oral referral' with the smell turning up as an experience in the mouth classified as 'taste', perhaps due to the simultaneous presence in the oral cavity of touch, or a tastant. This is what Rozin calls 'the location illusion', and when it occurs we get an inseparable combination of taste and retronasal smell leading to a unified experience of flavour. This fusing (or confusing) of smell and taste was demonstrated by Murphy et al. (1977) in normal subjects with purely odour-induced tastes:

When an aqueous (but tasteless) olfactory stimulus is placed into the mouth, subjects consistently interpret the sensation as a taste, rather than a smell, and state that the flavour is centered on the tongue, even though the sensory perception is principally mediated via the olfactory system. (Gottfried 2005, p. 473)

Conversely, there are taste-induced odours. When subjects chew mint-flavoured chewing gum until it loses its sweetness and 'taste' (odour) of mint, they can be asked to remove it from the mouth and rub it in icing sugar. When they put it back in the mouth, the mint returns even though there is no mint in icing sugar. Here, the recurrence of a taste boosts sub-threshold olfaction raising it to awareness.

Normally, the experience of flavour requires taste and *retronasal* olfaction, incorporating the smelling of odours arising from the mouth:

The use of the same word, 'taste', to refer to flavour and to the true gustatory

sensations of salty, sweet, sour and bitter leads to a variety of confusions. For a clinical example, where patients lost olfaction, they often report that they cannot taste or smell. However, when questioned, patients acknowledge that they taste salty, sweet, sour and bitter, but ‘nothing else’. The ‘nothing else’ is the contribution of retronasal olfaction to flavour. (Bartoshuk and Duffy 1998, p. 284)

Thus, smell contributes most to what we call ‘taste’ and yet this element of smell goes missing in experience. So, not everything about the experience of tasting is immediately available as part of a subject’s awareness. We are mistaken about the nature of these experiences: we tend to think they are tastes and due to sensations from the tongue. We think we know this because we think we have immediate access to these ‘simple’ sensations. Tasting was therefore thought to be thought rather simple, and until recently it remained vastly underexplored. The exception was Brillat-Savarin, writing in the nineteenth century, who was ‘tempted to believe that smell & taste are in fact but a single sense, whose laboratory is in the mouth & whose chimney is the nose’ (Brillat-Savarin 1835, p. 41).

4. The Nature of Flavour Experiences

We have concluded that what we call our experience of the ‘taste’ (flavour) of something arises through the multimodal integration of taste proper with retronasal olfaction. But to that we have to add somatosensory sensations, mechanoreceptors triggered by chewing, and trigeminal irritation. Chemical irritation of trigeminal nerve - the facial nerve that innervates the eyes, the nose and the mouth - is responsible for sensations of ‘coolness’ when eating peppermint, and the sensation of ‘heat’ when eating spicy food like mustard, even though there is no change of temperature in the mouth. Eating too much horseradish or wasabi mustard will burn at the bridge of the nose, not in the mouth, although the capsaicin in chilli will cause both trigeminal irritation and local oral burning. The trigeminal contribution is one of the hidden flavour senses, showing just how multisensory flavour perception really is:

Arguably, multi-sensory integration may be at its most extreme in the case of flavour perception since few other experiences offer the opportunity for concomitant stimulation of all the major senses: gustation through the five primary tastes, olfaction through both ortho- and retronasal stimulation of olfactory receptors by volatile compounds released from food, mechanoreception contributing to our perception of texture and providing

information on temperature, pain arising from oral irritants and hearing that results from sounds and vibrations coming from the mouth contributing to our perception of aspects of texture.(Yeomans et al. 2008, p. 565)

Notice that we can selectively attend to *some* of the multisensory components of flavour experience, such as the contribution touch makes to tasting: i.e. when a food or liquid's is described as being creamy, oily, crunchy, melting. But even the contribution of touch is not always so easily separable. Biscuits that 'taste' stale will have, at first, all the same taste and smell properties as fresh biscuits; it is simply that they crumble differently and this texture clue predicts decay and leads to us say they 'taste' stale. Similarly, the carbonation in fizzy drinks is a trigeminal irritant but it is hard to separate it from the way fizzy water, soda drinks or Champagne 'taste' to us.

Another reason for missing things in our tasting experiences is because, at first, we don't recognise that 'flavour perception is not a single event but a dynamic process with a series of events' (Piggott 1994). Tasting has a dynamic time course and slowing it down makes a difference to what we notice and what we can pick out. In this way, *how* we taste affects *what* we taste; and attending to each aspect of the dynamic time course changes the temporal scale of our tasting experience, allowing us to focus on particular qualities of the taste, texture and aroma of the foods and liquids we ingest. (It does not, however, mean that we can separate taste and retinasal olfaction.)

Taking these factors into account, how should we understand our experiences of flavour, what gives them the modal signatures they have for us, and how much of are we aware of in those experiences? We usually consider what we are experiencing when tasting as *tastes*, though it is still far from clear why we classify them as such, or how we conceive as this classification. Tasting is the activity through which we perceive the flavours of foods and liquids, like lemon, chicken or onion that we (mis)classify as tastes. As Yeomans says (above), the experience of flavour is a complex interaction effect. And yet, in the phenomenology of tasting, the experiences we have can strike us as whole, unified percepts. On the basis of that phenomenology, we are often unable to distinguish the sensory components that feed into such experiences. There may be no distinguishable, separable parts to a single flavour experience of raspberry, say, although we may be able to recognise the presence of single

flavours in a complex dish or wine. So how should we think of the parts that contribute to the experience of tasting a single flavour?¹

Must we say that we are mistaken about the nature of such tasting experiences, treating them as simple and unimodal when they are in fact complex and multimodal? That depends on which kind of facts we should turn to in order to settle questions about the nature of flavour experiences. Are they answerable for their nature to facts about the sensory processing that gives rise to them, enabling us to view them as products of multisensory integration? Or, as conscious experiences, should we take them to be just as we experience them: whole, unified experiences that are, in effect, just as they appear?

Those who take experiences to be simply a matter of how things appear consciously to a subject will suppose that a satisfactory account of their nature must be answerable to the phenomenological facts. Thus, it will be facts about the phenomenological character of those experiences that settles questions about the true extent and nature of those experiences. But how should we appeal to the facts about phenomenological character of our sensory experiences? What does it mean to reflect on them, and are the facts about their phenomenological character so transparently available to us? Are they self-illuminating? Just a matter of what occurs in consciousness? That issue will depend in turn on how we think about consciousness, and whether, for example, we accept Ned Block's distinction between access and phenomenal consciousness (a-consciousness and p-consciousness, see Block 2002). How much within consciousness goes on falls within the scope of the subject's awareness at any moment? Is it only what we reflect on that features in the facts about our flavour experiences? (I doubt that this is the right way to think of them.) But more pertinently, do we have bare encounters with the phenomenological facts of sensory consciousness? Or is what's available to us when reflecting on our conscious experience largely a matter of the phenomenological taxonomy we deploy to classify our experiences? Remember, being in a mental state is one thing: knowing what mental state one is in is another. The phenomenology is there but how should we taxonomize it? Is it an itch or a pain I'm experiencing? Am I exhilarated or anxious? The felt state itself does not decide? Philosophers are wont to forget this, and assume that the character of experience is transparently available to sub-

1 Notice, if such experiences are the result of a combination of "several inputs" coming from different sensory channels, there is a further far from easy to answer question about how these 'senses' are to be individuated (see Grice 1962).

jects of experience, using misleading talk of ‘what it is like’ to undergo such experiences. Whereas, it much more accurate to think that what I bring into focus as a result of directing my attention to how things are with me, because of this current phenomenological state, is *what I take it to be like*. That is, hot on the heels of our experience, and almost inseparable from it, is how we *take* an experience to be, and our *take* on our own experience is so tightly wedded to the occurrence of that experience itself that we often don’t notice there is an extra step to take and one which may be wrong in taking.

In the case of flavour experiences, our ordinary phenomenological taxonomy classifies them as unimodal experiences of taste; while psychology and neuroscience shows us that these seemingly simple ‘tastes’ are, in fact, the upshot of multimodal processing of olfactory, gustatory and oral somatosensory, trigeminal (and according to some auditory and visual) information, modulated by tasting’s dynamic time course. This neuroscientific classification of tasting experiences is at odds with our own take on them. So which of these classifications should we turn to when trying to understand the ultimate nature of those experiences? Must appearances (arising from our phenomenological taxonomy) be saved at all costs? Or should we see such appearances as getting something wrong about the ultimate nature of flavour experiences, thus requiring us to characterize them in another, more scientifically informed way?

This turns out to be an extraordinarily difficult question to answer. First of all, how do we *take* our experiences of tasting to be when we think of them as experiences of ‘taste’? We ordinarily believe experiences of taste to come from the tongue, and about this we are definitely wrong. But why does it feel so natural to think so? It is not as though the experiences carry any trace of their causal origins in the processing order, otherwise we would be mistaking these signs. It may seem that they wear their sensory character on their sleeves but do they? Is the connection to the tongue just a way we *think* about our experiences? Or is that because we are receiving sensations of taste and touch from the tongue that other sensory attention is captured and the experience is referred to the oral cavity? It could also be because we think of ‘tastes’ as originating in the foods and liquids we consume and that therefore, because our tongue is in contact with those substances it must be transmitting what we experience.

On the other hand, we could say that we are simply confusing ‘taste’ and

flavour, and that when we use the word ‘taste’ we are really talking about flavour. But then the mistake would be that we are thinking of flavour experiences as the upshot of one sense: as unimodal instead of multimodal experiences. Or, we could say that whatever word we use, we are really operating as though there was a distinct and distinguishable flavour sense – one the exercise of which gives rise to ‘tastes’ or flavour experiences, not realising how much that distinct sense draws on the senses of taste proper (gustation), smell (retronasal olfaction) and touch. (See Auvray and Spence 2007.)

It’s certainly the case that whatever people say or think they actually *are* experiencing flavours – not tastes. There may be no such thing, experientially, as the taste proper of a peach. (See Spence, Auvray and Smith 2013.) Without retronasal olfaction to discern peach odours there would be just sweetness and slipperiness, indistinguishable from other soft fruits. We know the experience people call ‘taste’ depends in processing terms on gustation, olfaction, somatosensation and sometimes trigeminal stimulation, but is the unified experience of flavour always a phenomenologically inseparable fusion of elements in experience, or is it a single conscious product of the integration of different sensory elements at the underlying processing level? The answer to this question lies at the heart of the matter, for what we are asking is whether however multisensory the processing of flavour experiences is, are flavour experiences themselves multimodal?

We do not recognise separable components of those experiences, but are different sensory elements nevertheless present in experience? The importance of this issue goes far beyond flavour perception since many results from cognitive neuroscience recognise are showing us that multimodal perceptions are the rule, not the exception.

5. **Multimodal Perception** There is reason to think our everyday perceptual experience is multimodal. We are simultaneously bombarded with sounds and sights, smells and feels, along with perhaps a taste in our mouths. We recognise distinct aspects of conscious experience, such as seeing or hearing, etc., but we are not aware of how interactive the senses are; not aware, that is, of cross-modal interactions where activity in one sense has an impact on another, nor of multisensory integration, where information from different sensory channels merge. In the case we are considering, namely, flavour perception, it is hard to recognise that tasting always involves at least taste, touch and smell. Unlike the component of touch, the fusion of retronasal olfaction and gustation seems

to be inseparably combined in experience, as we've seen. Nevertheless, by having our attention directed to aspects of flavour perception we can *sometimes* bring to light elements in these seemingly unified experiences. Think of the flavour of menthol, involving as it does: a minty aroma; a slightly bitter taste; and a cool sensation in the mouth. All three elements create a single, unified percept of menthol flavour. Absent one of them and you no longer have the flavour of menthol. However, it is possible to concentrate on any one of these co-occurring elements. Though we still need to have our attention drawn to each component.

In this way, there is both unity and complexity to our flavour experiences, and perhaps these occur at different levels in our mental architecture. Normally, flavours cannot be phenomenologically decomposed into a taste and a retronasal smell. So perhaps, the unity of a flavour experience is due to their integration at a pre-perceptual processing level that does not depend in any way on what we consciously do when we reflect on, or think about such experiences. It is simply in consciousness that we recognise a single, unified percept. So if we are talking about binding that occurs at a processing level, prior to any decision about, or categorization of, the flavour in question, or its qualities, and maybe it is at the processing level where the complexity resides. And yet in some cases different sensory elements can be acknowledged as with perception of menthol.

It would be important to have a clear taxonomy of cases – those in which we can distinguish different components and those in which we cannot. In the case of menthol, we have something more akin to the unity of flavours we find in a well-cooked dish where we recognise several flavours as together creating a harmonious and appreciable whole. In this case, the combination is appreciable at the level of perceptual experience. The flavour of the dish is perceived as a complex entity, possessing multiple elements or parts. Though even here we have a limited ability to identify the single flavours – or even particular tastants and odourants – when presented with a mixture of tastants or odourants.² In some cases it may not be very determinate whether we are perceiving a single flavour or multiple flavours. However, with single flavours like lemon, banana, or onion we need to know what contributes to and creates the unity creates a percept of a single flavour element. Do the sensory elements that combine outside of consciousness still make a showing in the conscious experience of a flavour?

2 See Laing, Link, Jinks and Hutchinson 2002; Marshall, Laing, Jinks, and Hutchinson 2006.

William James thought there could be experiences unified into whole but criticised what he called the “mind-dust theory”:

Take a hundred (feelings), shuffle them and pack them as close together as you can (whatever that may mean); still each remains the same feeling it always was, shut in its own skin, windowless, ignorant of what the other feelings are and mean.

Importantly for the the case of multisensory perception, it is James’ view that individual experiences can give rise to a more general experience, but that the new experience *does not contain* the individual ones:

There would be a hundred-and-first feeling there, if, when a group or series of such feelings were set up, a consciousness belonging to the group as such should emerge. And this 101st feeling would be a totally new fact; the 100 original feelings might, by a curious physical law, be a signal for its creation, when they came together; but they would have no substantial identity with it, nor it with them, and one could never deduce the one from the others, or (in any intelligible sense) say that they evolved it. (James 1890)

Applied to the general case of multimodal experience with simultaneous sensory inputs, a new experience of a made of auditory, visual and other components - components which could in other circumstances be experienced by themselves - but, are not figuring in the multimodal case as component parts within conscious experience. As Ophelia Deroy has put it: ‘this supposes that consciousness can *host* unified objects, but is not what unifies the component experiences’.

The question is whether we should think of cases of multisensory perception - the result of multisensory integration - in this way. Can we experience the components of such experiences by themselves in other circumstances? Consider the experiment of holding one’s nose while eating a jelly bean. This gives one the experience of sweetness or sourness alone, and when one lets go the nose the experience is transformed to reveal the flavour of strawberry, or pineapple, etc. previously unrevealed. At this point, the taste and retronasal smell have fused and they can no longer be separated even by special acts of attention. With nose held closed there is a taste of sweetness, then, after letting go a single, unified experience of a fruit flavour. So are taste and retronasal smell, nevertheless, both present in experience and just not recognised as such because of oral refer-

ral of the late: the location illusion where retronasal olfactory sensations are referred to the oral cavity? It's not clear. One can experience the sweetness or the sourness of the jelly bean, but one cannot, save for elaborate experimental set-ups involving inserted tubes, experience retronasal odours by themselves. Normally, one does not recognise this element of smell at all.

Of course, in the special case of menthol flavour, we are able to recognise the presence of both the slightly bitter taste and the minty aroma. Perhaps it's because a boost is given to the olfactory sensation by the trigeminally induced feeling of coolness due to the odour, thus alerting us to a lingering minty aroma in the nasal passages. Normally, however, we cannot achieve such isolation or awareness of the olfactory component, and tasters are usually surprised to learn that smell is involved so centrally in what they are tasting. Experience in tasting a single flavour comes as a whole, and only some parts of it could be experienced by themselves.

As all these effects demonstrate, the concoction of flavour experience is intricate and hard to focus on. But perhaps we should try to get at the nature of such experiences neither through a processing account nor the unified conscious result, but through what makes them *flavour* experiences as opposed to any other kind of experience. And the way to address this question would be to say more about what *flavours* are and try going on from there to give an account of how we experience them.

6. What are Flavours? Let's start by considering some definitions of flavour:

(1) Flavour is a 'complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting. The flavour may be influenced by tactile, thermal, painful and/or kinaesthetic effects' (AFNOR 1992)

(2) 'Flavour perception....should be used as the term for the combinations of taste, smell, the trigeminal system, touch, and so on, that we perceive when tasting food' (Auvray and Spence 2008)

(3) "Taste" is often used as a synonym for "flavour". This usage of "taste" probably arose because the blend of true taste and retronasal olfaction is perceptually localized to the mouth via touch (Bartoshuk and Duffy 2005, p. 27).

Each of these definitions acknowledge that the flavour experiences we have when tasting depend on sensory interactions, but they differ in mentioning different elements in the interactions. And despite being offered as definitions of flavour, what they actually describe are flavour experiences or flavour perceptions rather than flavours *per se*. (The definition of Auvray and Spence is here more careful, but elsewhere they collapse flavour and flavour perception.) If this conflation was deliberate it could be because flavours were to thought of as inseparable from our experience of flavours. More strongly still, in a view prominent among many psychologists and neuroscientists, flavours are not something we perceive: they are just psychological constructs (Prescott 1999) or items that arise only in the brain (Shepard 2012, Small 2013). The idea here is that it is the brain that combined information from taste, touch and smell to create flavours. Such configurations are just are products of the brain that arise from the binding of different sensory elements. A fairly typical neuroscientific statement of this view is given by Dana Small (following Gordon Shepard):

flavour is in the brain, not the food. It is the brain that integrates the discrete sensory inputs from the food and drink we ingest to create flavour perceptions. (Small 2013, p. 540)

The failure, here, to distinguish between flavours and flavour perceptions (c.f. colours and colour perception, sounds and sound perception) creates, as we shall see, problems for the individuation of flavour experiences. But for the moment let's pursue this view of flavours as arising in us because of sensory combinations produced by the brain.

Consider the three definitions of flavour (perceptions) just given. How are the different components mentioned in each definition bound together? The talk here is of a 'combination' or 'blend'. More importantly, exactly which components get bound together in flavour perceptions? In (1) there is mention of olfactory, gustatory and trigeminal sensations; in (2) there is the addition of 'touch, and so on'; while in (3) flavour is restricted to 'the blend of true taste and retronasal olfaction' where the blending is only mediated by touch.

These different views about which sensory elements go into the multisensory integration that produces flavour perceptions require somewhat different processing stories regarding the how-part, ie. the *combining*, and the

what-part, the *contributors* to the binding problem. The answer given to the HOW question and the WHAT question constrain one another: what is the ultimate product of combining inputs from different sensory systems, and how do the different sensory inputs combine?

7. Rules of Multisensory Integration

As we have seen, it is a non-trivial task to explain multisensory integration, and as was said above, any fully adequate account of how this happens in flavour perception would cast significant light on the nature of multisensory perception in general. Such an account is still out of reach but it is being pursued vigorously in the sensory sciences, and the literature contains many suggestions of the sorts of rules and properties that may be involved in multisensory integration. Prominent amongst these are the following:

- (i) Spatio-temporal Unity
- (ii) Superadditivity
- (iii) Sensory Dominance
- (iv) Semantic Congruence

(i) Spatio-temporal Unity

The spatio-temporal unity hypothesis is this: the unity of flavour comes from the fact that sensory information of various kinds, or from various origins is put together when presented as close in time and space. So does the unity we find in the flavour experiences just come from the spatio-temporal conjunction of sensory inputs we have when eating and drinking? Not quite. The interaction between the multimodal components goes beyond mere co-occurrence in consciousness.

(ii) Superadditivity

We can see a plastic water bottle being crushed, and we can hear a plastic water bottle being crushed, but when we both see and hear the water bottle being crushed the neural activation of the perceiver is greater than the sum of the separate activations for the visual and the auditory stimuli. This is superadditivity: a clue to multisensory integration and a sign of how important such events are to the brain. However, superadditivity can also occur with out intergration, as in the case of cross-modal effects like sweetness enhancement. Combining vanilla aroma with a sucrose solution, where the aroma is sensed orthonasally by inhaling, will make that solution taste sweeter. This is the sweetness enhancement effect (Cliff and Noble 1990; Frank et. al 1991; Dalton et. al 2000). Now although we can recognise the

presence of an odour and a taste, we are unaware of how they are interacting to boost the perception of sweetness. This cross-modal effect results in a conscious experience but is not the result of conscious combining. Being presented with just sub-threshold vanilla aroma and just sub-threshold sweetness for a sucrose solution will result in a conscious experience of sweetness. Other factors affect the perception of sweetness, such as a creamy texture which can enhance the perceived sweetness, and there are interactions between odours and textures. (Bult et al. 2007). Certain aromas make what's in the mouth taste creamier, and certain textures can change aroma profiles. Is this just due to spatio-temporal combining? It seems to go far beyond it is ways we could not have predicted from the co-occurrence of these sensory events.

Moreover, if space and time are the only factors of unity for a flavour F, then all information that is processed or perceived as close enough in time and space, or attributed to a single cause in space and time, will be components of F. So are the sounds heard during crunching an apple or a carrot part of its flavour. They can certainly affect the overall experience of the food (Zampini and Spence 2004) so should they therefore be treated as components of flavour. Is there such a thing as auditory flavour?

And what of visual properties of the eating environment, such as lighting, which can affect the experience of the food and therefore are components of flavour. Does this mean we need to recognise visual flavour?

Then there is the perceived weight of the food in the hand – different bowls of the same yogurt, one with a weight at the bottom, will, when handed to participants to try, affect their perception of the texture, thickness, richness of the yogurt in each bowl (Spence 2010). So is the weight of the container a component of flavour? Surely, we should say that these factors can causally affect our perception of flavours, but they are not constitutive (i.e., not components of) flavours or flavour perceptions. This is a philosophical point that needed to be stressed. Not every component or feature of our experience of an object or event reveals a constitutive part of that object or event. We need to distinguish co-occurring or causally affecting versus constitutive features of our experience of tasting. There is no agreement on WHAT is necessary or constitutive of flavour experience. This true for hedonics, too, because we could ask on the spatio-temporal unity hypothesis whether the hedonic - affective - component of eating and drinking is

a constitutive part of flavour or flavour perception. Some have said yes (see Verhagen 2007) and others no (see Smith 2007, 2010), while for others it is indeterminate, though they go together and are tested together (see Yeomans 2008). Notice, that it would be hard to exclude this feature if we adopted the spatio-temporal unity hypothesis. But we should exclude it. The overall experience that we have when eating may overflow the experience or perception of flavour. Even if people think the main purpose of eating and drinking is to determine whether it is pleasurable or not, and whether they want more or want to stop, this is different from how the food or drink tastes and what its qualities are. If force-fed the same food repetitively, even a food we like such as chocolate, we may suddenly find the hedonics switching around from liked to disliked. This is stimulus specific satiety. The identity of the stimuli stay the same even when the hedonics vary, for if you were suddenly offered a different type of chocolate you would notice. (Kringelbach and Stein 2010; O'Docherty et al. 2000) Also, an experienced taster should be able to assess the character and quality of a wine even if it is not to his or her taste.

(iii) *Sensory Dominance*

We have seen that the spatio-temporal hypothesis does not explain superadditivity. Nor does it explain patterns of dominance, as when vision dominates audition in the *vetrioloquist* effect, where there is visual capture of auditory attention, re-locating our auditory experience to the location of the visual source. Nor does this hypothesis accommodate the role of 'expectations' in the explanation of perceived flavours since expectations exist prior to, and independently of, the actual occurrence of stimuli at that time or space. In the sensory and food literature, expectations can have a big impact on perceived flavours. Expectations generated by the color of a food or beverage, experienced *before* it is tasted (and stimulation occurs) can lead to enhanced (or diminished) perceptions of sweetness or sourness (see Spence et al. 2010), because linked to the recognition of a certain kind of food giving rise to expectations of corresponding kinds of flavours. For example, the more intense the color, the more intense the flavour. Expectations generated by different linguistic description of the same food (Yeomans et al. 2008) with smoked salmon ice cream tasting saltier and more savoury when labelled as a novel flavour of ice cream rather than as a "frozen savoury mousse".

Leaving aside these issues there are other problems for this hypothesis. How

do we go from the spatio-temporal combining of multisensory elements to a unified percept (At what level does unity occur, and how it is manifest to the subject?) Perhaps, space-time and some unity assumption can explain why a *single object or event* is perceived, but how can they explain what we come to perceive this object or event as being (e.g. a taste or smell)? And notice, we have not answered the WHAT question about which elements from the range offered in definitions (1) to (3) above go into flavour perception. We should also ask what role is played by each of the components, for example touch, in (1) – (3)?

(iv) *Semantic Congruence*

In returning to the HOW – question, can focusing on semantic congruency reveal a necessary feature of the relation that constitutes flavour experience? According to some, it helps addressing the WHAT issue. Combinations of qualitative features (odour-taste, odour-colour) is conditioned by congruency. For example, strawberry odour + (congruent) sweet taste are combined into a flavour, but strawberry odour + (incongruent) salty taste are not, or less so. Congruency could also explain the role of expectation in flavour experiences. Colour-smell expectations depend on the congruency of the two pieces of information. Perceived intensity depends on congruency: a lime green drink should taste more sour, and a deep red, more sweet, than a neutral coloured drink. Sweetness enhancement effects are specific to certain congruent odour-tastant pairs. (see Prescott 2004). Eg: caramel odour + sweet tastant gives rise of sweetness enhancement. Chicken odour + sweet tastant does not. Can the congruency hypothesis explain oral referral? We get this, and so experience flavours for congruent pairs of taste-odours. Lim and Maxwell (2012) give preliminary results in which when a congruent taste(s) was added to an odour, referral to the oral cavity and tongue were significantly enhanced. The degree of congruency between taste and odour may modulate the degree of odour referral to the mouth. So congruency could help explain localisation too. The Congruency Hypothesis is this: unified flavours are constituted by congruently related sensory cues. Congruency is not to be thought of as ‘all or nothing’ - a sensory cue S1 is more or less congruent with sensory cue S2. Flavours would be constituted by these various ‘more or less’ congruency relations. Their role in determining flavours suggest they intervene at the level of processing and (somehow) determine categorisation. They can result in an determinate flavours (e.g. chicken). Or they can still be manifested as flavours with more or less resolution (e.g. chicken-like flavour, definitely not a citrus flavour. Could be a different poultry animal).

8. **What is
Congruency
and What
Explains It**

If congruency of different sensory stimuli or inputs is supposed to explain the unity of flavour experiences, we need to ask what explains congruency?

It would be easy to explain congruency by saying when two features are considered to be attributes of the same kind of object: strawberry smell + sweet taste + red colour + strawberry-shape, they belong to one food or fruit. But this presupposes a unity and category to which these features belong as an ecologically valid part of the environment. However, if there are no such configurations in the world but only flavour made in the brain, the congruence of flavours cannot come from the outside. All we can fall back on are *sensory congruencies*. This means when two features 'match' so that the estimation of one will affect the estimation of the other: e.g. the darker the colour, the more intense the flavour (ripeness) the heavier, the thicker the yogurt (density correspondence). Why are some sensory pairings congruent? Without resort to semantic congruencies, determined by co-occurring configurations of texture, taste, odour and irritant properties of foods and liquids, giving them flavour profiles, we just have sensory congruencies where features 'match' and determine which bundles are flavours: These remain subjective, internal and unexplained; flavours as complex sensations, revealing nothing beyond themselves.

But rather than settle for this unexplanatory stopping point, with no way to prescribe precisely the set of flavour experiences, there is the option of positing flavours as properties of foods and liquids. On this view, we could see flavours as affordances which our capacities of flavour perception tracks so as to guide successful food choice.

By recognizing that flavours are external features of the environment we need not see flavours and flavour perceptions as always coinciding. How we taste affects what we taste: the dynamic time course in tasting affects what we can pick out when, and a series of perceptual events will allow us to build up a profile of the foods and liquids we experience. Tasting is the activity by which we assess what we ingest or imbibe hedonically, but this is done on the basis of perceptual experiences and these are perceptions of flavours. Each act of tasting is a snapshot of a flavour profile that we may explore by repeated tasting or experiments with flavours. The term *flavour* does not describe a construct of the brain, but it is a technical term used to describe the sapid and odourous properties of a solid or liquid, including properties of its temperature and texture, as well as the power to irritate the trigeminal nerve. Config-

urations of these properties are flavours and we use multiple senses to track them. Multi-sensory integration unites information from different sensory inputs into perceptual experiences of flavour, where the exact nature of these experiences depends on the precise arrangements of textures, odours, and tastants/ irritants that generate the sensory inputs. The more unified the configurations that make up flavours, the more unified but complex are the flavour experience whose parts we are unable to distinguish. The science of the HOW-WHAT questions about the nature of flavour perceptions leaves room for objective flavours. Flavours are more than a set of *congruent* relations between *congruent* sensory properties: such congruent sensory properties may track congruent real properties of foods and liquids that cause them. It's nature and chefs that make flavours, not brains. Finally, we must distinguish the hedonics of eating from the perceptual experience of tasting. Eating experience overflows flavour perception. The sound of the crispness of an apple is not part of flavour, but it is part of the pleasurable experience of eating it. Many aspects that contribute to the hedonic responses that we suppose to be bound up with, and revealing of, the flavour or 'taste' of something may overflow flavour and professional tasters often have to set them aside.

- 9. Conclusion** We have seen a need to distinguish flavours from flavour experiences, and to see the latter as arising from the combined and integrated use of sensory inputs to keep track of the latter. Such experiences are mostly unified and yet hard to extricate, at times, from wider notions, such as the overall experience of eating or drinking, which includes a hedonic response. The case of flavour experiences presents a challenge to any philosophical theory that supposes we have immediate and authoritative knowledge of the nature and character of our own sensory experiences, or that our senses simply inform us about the character of our experience. It has taken much recent research in psychology and neuroscience to reveal the complexity and interactions between our sensory experiences and to direct our attention to aspects of those experiences that were overlooked in conscious awareness. Even now, we face a challenge to say how the integrations of sensory information in brain gives rise to unified percepts in conscious experience, and what the ultimate nature of those conscious mental items is.³

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