Philosophical Issues, 18, Interdisciplinary Core Philosophy, 2008

BASIC SENSIBLE QUALITIES AND THE STRUCTURE OF APPEARANCE

Alex Byrne
Massachusetts Institute of Technology

David Hilbert
University of Illinois at Chicago

1. Introduction

A *sensible quality* is a perceptible property, a property that physical objects (or events) perceptually appear to have. Thus smells, tastes, colors and shapes are sensible qualities. An egg, for example, may smell rotten, taste sour, and look cream and round.[1,2]

The sensible qualities are not a miscellaneous jumble—they form complex structures. Crimson, magenta, and chartreuse are not merely three different shades of color: the first two are more similar than either is to the third. Familiar color spaces or color solids capture, to a greater or lesser extent, these relations between the colors. The same goes for sensible qualities perceived in other modalities: middle C, high C, and D are not merely three different notes, and the taste of lemons, oranges, and sugar cubes are not merely three different tastes. How can this structure of appearance be explained?

One idea is that sensible qualities are of two sorts: basic and derived. The basic sensible qualities are the building blocks from which the derived sensible qualities can be constructed. And the way the derived qualities are constructed from the basic qualities explains the structure of appearance. Something like this picture is often suggested in discussions of color. Following the nineteenth century German physiologist Ewald Hering, Hardin writes that "of the many hues discernible by human eyes, exactly four are perceptually elemental. These *unique*, or *unitary* hues—red, yellow, green,

and blue—appear to have no other hues as constituents. All of the other hues, such as orange, purple, lime, and turquoise, to name but a few, seem to be *binaries*, that is, blends of pairs of the elementary hues" (Hardin 2008: 147). On this account, there are six basic colors, four chromatic (red, yellow, green, blue) and two achromatic (black and white).[3,4] And most people are familiar with the four (so-called) "basic tastes": sweetness, sourness, saltiness and bitterness. These basic tastes are said to be "components" (Halpern 2002: 654) of more complex tastes. And there is supposed to be a *fifth* basic taste ("umami", or savoriness), that the Chinese have been familiar with for a few thousand years. This fifth taste, as a recent NPR news item has it, "was neither sweet, bitter, sour, salty nor any combination of those four" (Krulwich 2007). Somewhat mysteriously, westerners apparently needed the techniques of modern neuroscience to discover it for themselves.

But what is it about certain colors or tastes that makes them basic? And in what sense are they "constituents" or "components" of other colors and tastes? The literature on taste, in particular, is in some disarray on this point. According to Robert Erickson (a leading taste researcher), "[T]he idea of 'four primary' [basic] tastes is certainly the most central one in taste today". But, Erickson immediately goes on to say, "although it seems a relatively simple concept, it is not universally clear what the idea of 'four tastes' is" (1984: 105). And in a recent *Behavioral and Brain Sciences* target article he argues that "although the idea of basic tastes has directed our research for over a century, we don't know what basic tastes are; we don't know the origins, rationale or definition of this idea, and thus we do not explicitly know how to test it" (Erickson 2008: 60).[5]

Color and taste are arguably the most natural candidates for the basic-derived approach, so we will concentrate on these two. For simplicity, we will mostly ignore some aspects of both color and taste. In the case of color, we will set aside lightness, and concentrate on hue.

Taste is less straightforward. First, there is a distinction between *taste* and *flavor*: the latter is sensed by the nose and mouth as a whole, and so includes odor, texture, and temperature. Taste is more limited, and is sensed solely by receptor cells in taste buds on the tongue, the roof of the mouth, and throat. ('Taste', in the vernacular, usually means *flavor*.) Second, there is a distinction between (at least) two aspects of taste, *intensity* (the degree to which something is sweet, tart, savory, etc.) and—what is usually simply called—*taste* (sweetness, tartness, etc.). We will ignore intensity, and concentrate on taste.[6]

This paper has two main aims. The first is to give an account of basic sensible qualities, clearing up some confusions along the way. It will turn out that although basic tastes might explain the structure of gustatory appearance, the same sort of explanation cannot work for colors. The second aim is to outline an alternative explanation of color appearance. These two

explanations of the structure of appearance are species of a common genus: in a sense to be explained, they are both *representational* explanations.

Our investigation concerns certain perceptible qualities, but there is nothing mental about the qualities themselves, or the items that possess them. If colors and tastes are properties of anything at all, they are properties of familiar non-mental objects like lemons and drops of lemon juice. Of course, perhaps the structure of our own minds is somehow relevant to the investigation, but even this should not be assumed at the outset. It is especially important, then, not to confuse (basic) *sensible qualities* with mental items or properties—in particular, with (basic) *sensations*, (basic) *sensory* qualities, or (basic) *sensational* qualities. Since there is a long and distinguished history of confusion, some clarificatory remarks are needed.[7]

1.1. Sensations and sensory qualities

Start with the first two of the trio just mentioned: sensations and sensory qualities. F. A. Hayek's *The Sensory Order* begins by explaining that

> [f]or the purposes of this discussion we shall employ the term sensory 'qualities' to refer to all the different attributes or dimensions with regard to which we differentiate in our responses to different stimuli. We shall thus use this term in a wide sense in which it includes not only quality in the sense in which it is contrasted with intensity, extensity, clearness, etc., but in a sense in which it includes all these other attributes of a sensation. We shall speak of sensory qualities and the sensory order to distinguish these from the affective qualities and the other mental 'values' which make up the more comprehensive order of 'mental qualities'. (Hayek 1952: 2)

Sensory qualities, then, are mental qualities, specifically "attributes of a sensation". And sensations, or "sense experiences" (3), are "events taking place in some organism" (16).

One may then speak of basic sensory qualities and, derivatively, of basic sensations. A basic sensory quality is one that cannot be decomposed into other sensory qualities. A basic sensation is a sensation that instantiates only one sensory quality, which is basic.

What are some examples of sensory qualities? Hayek offers "colours, sounds, odours, feeling of touch, etc." (3). That is, according to Hayek, sensory qualities—properties of sensations—are what we earlier claimed were *sensible* qualities, ostensible properties of objects like eggs and tomatoes. There is no inconsistency here. Although presumably colors are not properties of *both* sensations and physical objects like eggs, they might be properties of the former that (misleadingly) *appear* to be properties of the latter.[8] And that seems to be Hayek's view. At any rate, immediately after giving this explanation Hayek says:

> A precise statement of the problem raised by the existence of sensory qualities must start from the fact that the progress of the physical sciences has all but eliminated these qualities from our scientific picture of the external world. (2)

In a footnote he quotes from Planck's *A Survey of Physics*:

> The sense perceptions have been definitely eliminated from physical acoustics, optics, and heat. The physical definitions of sound, color, and temperature are today in no way associated with the immediate perception of the respective senses, but sound and colour are defined respectively by the frequency and wavelength of oscillations, and temperature is measured theoretically on the absolute temperature scale corresponding to the second law of thermodynamics. (Planck 1926, 5)

Science, then, has only turned up correlates of sensory qualities in our external environment—"the frequency and wavelength of oscillations"—not the qualities themselves.

What is somewhat puzzling is why Hayek thinks that although nothing in the external world is colored or noisy or tasty, items in the "internal" world, specifically sensations or "sense experiences", have these qualities. Why not say instead that absolutely nothing has these qualities?

Whatever the answer to that question may be, early psychologists tended to take it as simply obvious that sensations had colors, sounds, and so forth:

> Sensations have always been distinguished by their qualities. Every sensation can be said to have an attribute of *quality*, which designates it as red or yellow or bitter or cold or C#. (Boring 1933: 19)

And the view persists today, especially in the literature on taste. Tastes are frequently supposed to be sensory qualities or sensations. Similarly, "basic tastes" are taken to be basic sensory qualities or basic sensations:

> [R]esearchers generally describe taste quality in terms of four basic taste sensations: salty, sour, sweet, and bitter. (Goldstein 2002: 490)[9]

It should be emphasized that these sort of quotations are not *obviously* problematic. 'The soup produces a salty sensation in my mouth', for example, can be given a harmless paraphrase as 'A portion of soup in the mouth tastes salty'—here saltiness is not being attributed to something mental, a "sensation". However, given Goldstein's earlier remarks about "some perceptual qualities" being "literally created by our nervous system" (205–6), the quotation should probably be given a sinister interpretation in line with the quotation from Boring.[10]

People certainly perceive things—they taste the soup, smell the cheese, and so on. If that is all that is meant by the claim that there are "sense experiences" or "sensations", then the claim is harmless. But often the claim is strengthened along Hayek's lines, with sense experiences or sensations understood as particular mental events, whose sensory qualities are introspectable by the person in whom they occur. So understood, sensations (and sensory qualities) are arguably a myth. But for our purposes, we can stick with the (now) relatively uncontroversial observation that sensory qualities, if they exist at all, are not sensible qualities. If there are particular "sense experiences", then their features do not include colors, tastes, and sounds.

1.2. Sensational qualities

When one sees an egg, one is aware of the egg and its apparent (sensible) qualities. Is one also aware of *other* items, not part of one's external environment, that somehow mediate one's awareness of the egg? Locke, for example, seems to have thought so. According to Locke, the egg produces various "ideas" in one's mind, which are "the immediate object[s] of Perception" (Locke 1689/1975: 134). These ideas include ideas of color and shape. And it is the "actual receiving of *Ideas* from without, that gives us notice of the *Existence* of other Things" (630), such as eggs. Lockean ideas—specifically, "*Ideas* got by *Sensation*" (117)—are, of course, precursors of the *sense data* of the twentieth century. Like ideas, sense data were supposed to be the immediate objects of perception, and were usually taken to be mind-dependent. Let us say that the perceptible properties of sense data are *sensational* qualities. Traditionally, sensational qualities were identified with *sensible* qualities: thus the sense datum produced by the egg is both oval and cream. And that identification has also been ascribed to Locke.[11]

As with the parallel identification of sensory qualities with sensible qualities, this view is not inconsistent. Assuming that colors are not properties of *both* physical objects like eggs and mind-dependent sense data, they might be properties of the latter that (misleadingly) *appear* to be properties of the former. But we need not discuss this issue further, because we will assume, with current orthodoxy, that there are no sense data (or Lockean ideas) and hence no sensational qualities.

Still, Locke is certainly relevant to present concerns, because the notion of a basic sensible quality can be extracted from the following passage about *simple ideas*, which we will briefly return to in section 3.2:

> Though the Qualities that affect our Senses, are, in the things themselves, so united and blended, that there is no separation, no distance between them; yet 'tis plain, the *Ideas* they produce in the Mind, enter by the Senses simple and unmixed. For, though the Sight and Touch often take in from the same Object, at the same time, different *Ideas*; as a Man sees at once Motion and Colour;

> the Hand feels Softness and Warmth in the same piece of Wax: Yet the simple *Ideas* thus united in the same Subject, are as perfectly distinct, as those that come in by different Senses. The coldness and hardness, which a Man feels in a piece of *Ice*, being as distinct *Ideas* in the *Mind* as the Smell and Whiteness of a Lily; or as the taste of Sugar, and smell of a Rose. And there is nothing can be plainer to a Man, than the clear and distinct Perception he has of those simple *Ideas*; which, being each in it self uncompounded, contains in it nothing but *one uniform Appearance*, or Conception in the mind, and is not distinguishable into different Ideas. (Locke 1689/1975: 119–20)

2. Primaries and Physiology

The operative idea of a basic quality in this paper is (for want of a better word) *phenomenological*. Basic qualities are supposed to be perceptible "constituents" or "components" of other qualities. In the literature on taste, especially, this phenomenological conception of basicness often appears alongside two other, entirely separate, conceptions.

The first of these is the conception of basic qualities as *primaries*—as characterizing a minimal set of ingredients that can be *physically combined* to form compounds with derived qualities. Kurihari and Kashiwayanagi, for example, give four criteria for a taste to be basic, one of which is that "[a] basic taste is not reproduced by mixing together the other basic taste stimuli" (2000: 932S).

The second is the *physiological* conception of basic qualities: a basic quality is one detected by a distinct physiological mechanism, processing information solely from a dedicated type of receptor. As Kurihari and Kashiwayanagi put it, "[a] basic taste should be proved electrophysiologically to be independent of other basic tastes" (933S). The claim that there is a distinct physiological mechanism for each of a small number of tastes is called the *labeled line theory*.

Often these three conceptions of basicness are not separated as sharply as they should be—and sometimes they are conflated. So before we turn to the phenomenological conception, some discussion of the other two is in order.

2.1. Primaries

Mixing together substances with different tastes typically produces a substance with a new taste. Similarly, new colors can be obtained by mixing colored paints or dyes (subtractive mixtures) or colored lights (additive mixtures). In popular discussion and the arts the colors that can be mixed to produce all (or at least a great many) of the other colors are called the *primary* colors. The other colors are divided into *secondary* and *tertiary*

colors, depending on the mixtures of the primaries used to generate them. Usually the relevant sort of mixture is subtractive (pigment mixtures), but sometimes it is additive (light mixtures). Further, it is sometimes supposed that there is a unique set of primaries, as in this early twentieth century example:

> In dealing thus with pigments we find that there are three Colors which are the basis of all other colors, and that these three are yellow, red and blue. (Snow and Froehlich 1920: 15)

A parallel suggestion occasionally surfaces in the taste literature:

> In color vision, the primary colors, typically red, green and blue, are those that can be mixed together to create all spectral colors . . . The four basic tastes could be defined as primary in the same sense. (Delwiche 1996: 412)

Delwiche objects to this definition of a basic taste on the ground that sweetness, sourness, saltiness and bitterness are not, in fact, a set of taste primaries:

> However, the mixing together of taste compounds that are representative of sweet, sour, salty and bitter tastes is not sufficient to recreate all tastes. Even the attempt by von Skramlik to reproduce tastes by mixing representative stimuli of the four primaries, which is frequently interpreted as being successful, was not entirely so. (412)[12]

But this is not particularly convincing. Instead of showing that the account of basicness in terms of primaries is inadequate, why doesn't it just show that the basic tastes are not exhausted by the traditional four? Perhaps armed with a few more tastants von Skramlik would have been able to recreate all tastes, or perhaps an entirely different set of tastants would have done the trick (cf. Halpern 1997: 100–1).

In any case, even if all tastes can be produced by mixing together certain sweet, sour, salty, and bitter ingredients, the important point is that this does *not* show that there are basic tastes in the phenomenological sense. As an illustration, let us take additive color mixing, which raises the fewest complications.

First, despite the name, the color primaries are not, at least in the first instance, colors. Rather, a set of (additive) color primaries is a set of *lights* such that no member of the set can have its appearance matched by a mixture of the remaining members, and which can be mixed to perceptually match all lights. Because human vision is trichromatic, a set of color primaries will have three members. These primaries will themselves be (or appear) colored, of course: so, given three primaries, there will be exactly three corresponding

colors. In fact, if three colors are the colors of a set of primaries, then any lights that match the set in color will also be a set of primaries. So one can speak derivatively of primary "colors", although it must be borne in mind that only lights are literally mixed.

Second, there is no unique set of primaries—in fact, there are indefinitely many. Some of these sets of primaries will be more useful than others in various practical applications, but there is no sense in which the members of one set are "the" primaries. There is not even a unique set of primary *colors*—although a typical set of three primary colors will contain various shades of red, green, and blue.

Third, although the primaries are literally mixed, they need not be components of the stimuli that they match. For example, one classic color matching technique requires subjects to match a 589 nm (yellow) light to a mixture of two primaries: a 545 nm (green) light and a 670 nm (red) light. The ratio of the amounts of the primaries required by an individual for a match provides useful information about defects of color vision. Notice, however, that although a mixture of 545 nm and 670 nm lights can match a 589 nm light neither primary is a component of the 589 nm stimulus. A specification in terms of primaries does not give a recipe for producing every stimulus; rather, it gives a recipe for producing a stimulus with the same appearance.

Thus talk of "mixing" primary *colors* is wrong and also highly misleading. The only things that literally get mixed are lights (in the case of additive mixing), not the colors themselves. Even talk of mixing primaries has to be treated with caution. If a red light and a green light are mixed to produce a yellow light, the resulting light is composite, but this does *not* show that yellow lights (or lights of this particular shade of yellow) are composite. And, most importantly, these facts about mixing primaries have no bearing on the topic of this paper: yellow manifestly does not have red and green as perceptible components.[13]

In short: although primaries are very useful in psychophysics and elsewhere (in particular, color primaries provide the basis for most systems of color reproduction), they should be sharply distinguished from the phenomenological conception of basic qualities.[14]

2.2 Physiology

A crucial insight into sensory physiology is that it is possible to explain the perception of sensible qualities that form a continuous manifold, such as colors, in terms of the activity of a small number of types of receptors. In a striking piece of reasoning, confirmed by direct measurement nearly two centuries later, Thomas Young argues that the diversity of perceived color is the result of the operation of just three types of receptors:

> Now, as it is almost impossible to conceive each sensitive point of the retina to contain an infinite number of particles, each capable of vibrating in perfect unison with every possible undulation, it becomes necessary to suppose the number limited, for instance, to the three principal colours, red, yellow, and blue, of which the undulations are related in magnitude nearly as the numbers 8, 7, and 6; and that each of the particles is capable of being put in motion less or more forcibly, by undulations differing less or more from a perfect unison; for instance the undulations of green light being nearly in the ratio of 61/2, will affect equally the particles in unison with yellow and blue, and produce the same effect as a light composed of these two species: and each sensitive filament of the nerve may consist of three portions, one for each principal colour. (Young 1802: 20–1)

In outline, although not in detail, Young's theory matches the current understanding quite nicely. Color vision is based on the outputs of three types of receptors which differ from each other in how sensitive they are to different wavelengths in the visible spectrum. The color perceived in response to a particular stimulus is determined by a comparison of the outputs of the three receptor types.

It is an interesting question to what extent the perception of other sensible qualities results from an initial stage similar in structure to that found in color vision. Our other running example of taste perception provides perhaps the closest comparison. On the standard (and simplified) textbook account, taste perception is initiated by the activity of (at least) four receptor types, corresponding to the four basic tastes: sweet, sour, salt, and bitter. (Often a fifth receptor is included, corresponding to the umami taste.) However, unlike color there is no analogue of wavelength; that is, there is no single simple physical dimension on which the sensitivies of the taste receptors can compared. The ways in which taste receptors differ in their sensitivity to different chemical substances are complex and heterogeneous. To a first approximation, the sour receptors respond to hydrogen ions, and the salt receptors respond to sodium ions. The sweet receptors respond to something considerably more complicated (sugars, roughly) and the substances that trigger the bitter receptors are chemically quite diverse. Nevertheless, the textbook model of taste perception gives it a broadly similar front end to color vision: there are small number of receptors that differ from each other in their relative sensitivity to different stimuli.

A simple receptor-based physiological conception of basicness identifies a basic quality as one that is the best stimulus for a particular receptor type. Thus the basic colors are those that preferentially stimulate one of the three cone types. Something like this idea is embodied in the once common convention of labeling the three cone types with the names of three "primary" colors, red, green, and blue.[15]

The case of color clearly demonstrates that the receptor-based physiological conception of basicness comes apart from the phenomenological

conception. At least in the case of spectral lights, the (apparent) colors corresponding to the peak sensitivities of the L-, M- and S-cones are, respectively, greenish-yellow, yellowish-green, and bluish-violet. Obviously these are not basic colors in any phenomenological sense.

There may well be connections between the phenomenological conception and physiological conceptions of basicness that involve neural 'labeled lines' downstream from the receptors. However, such connections are largely a matter of speculation, mainly because nowhere near enough is known about the relation between neural processing and perceptual appearances. And, although it might be that an appropriately detailed version of the labeled line theory is sufficient for there to be basic qualities in the phenomenological sense, there seems to be no reason to think anything like it is necessary.

3. Constituency and Singularity

We now turn to the phenomenological conception of basic sensible qualities. On the phenomenological conception, basic sensible qualities are perceptually apparent "constituents" or "components" of the derived sensible qualities. But what does this mean?

3.1. Constituency

Begin with this clarificatory question: if quality Q has P and R as constituents, what is the relation between having Q and having P and R? Although the literature on color is of little help, a clear answer is implicit in the literature on taste. Let Q be the taste of dark ("bittersweet") chocolate. If Q has the basic tastes bitterness and sweetness as constituents, then (necessarily) an object has Q iff it is both bitter and sweet.

Now, if we take this talk of "constituents" or "components" literally, the basic sensible qualities are *parts* of the derived qualities. And on one theory of properties, notably Armstrong's (1978: 30–9) some properties *do* have parts. In particular, a conjunctive property P&Q has properties P and Q as parts. On what we can call the *metaphysical* account of basic qualities, they are the parts from which the derived conjunctive qualities are built.

It would be a discomforting result if the basic tastes model required a highly controversial metaphysics of properties, but fortunately the metaphysical account of basic qualities is inadequate. The constituents of a particular thing are sometimes hidden from ordinary perceivers—the atoms in this bar of chocolate, for example. Similarly, on Armstrong's theory, the constituents of a property can also be hidden—something might appear to have a property that is in fact the conjunctive property P&Q without either appearing to have P or appearing to have Q. Indeed, Armstrong himself thinks that sensible qualities have constituents that can only be revealed by science, not ordinary

perception. So, on the metaphysical account of basic qualities, the fact that a certain taste has bitterness and sweetness as constituents is no guarantee that the constituents are apparent—no guarantee, that is, that anything with that taste either tastes bitter or tastes sweet.

This might suggest that the metaphysical account needs to be supplemented, rather than overturned. However, if we now make the needed addition, and insist that the taste of chocolate has bitterness and sweetness as "constituents" iff chocolate tastes both bitter and sweet, then the metaphysical account of basic qualities is entirely redundant. If chocolate tastes bitter and tastes sweet, then it tastes bitter and sweet, and in that sense has a "conjunctive taste". However, it does *not* follow that the taste of chocolate is an Armstrongian conjunctive property with bitterness and sweetness as constituents. Similarly, the fact that a tomato looks red and round does not imply anything about the metaphysical structure of the property of being red and round.

Talk of basic qualities being "constituents" or "components" of derived qualities is thus confusing, at best. The claim that bitterness, sweetness, sourness, and saltiness are the four basic tastes is best understood, we suggest, as the conjunction of two claims. First, every tastant tastes bitter, and/or sweet, and/or sour, and/or salty. Second, bitterness and the other three are not themselves "conjunctive tastes"; that is, to taste bitter (etc.) is not to taste x and taste y and . . . , for distinct tastes x-ness, y-ness, ... Assuming the common view that perceptual experience has representational content (Siegel 2005), the four taste model can put as follows: except when the content of gustatory experience predicates just one of the four basic tastes, the content of gustatory experience always has a simple conjunctive predicational component—that the tastant is bitter and sweet, or bitter and sweet and sour, for instance.

The right account of basicness is thus *representational*: on the four taste model, chocolate is *represented as* both bitter and sweet. We now want to connect the representational account with a distinction in the psychological literature between perceptual "synthesis" (or "singularity") and perceptual "analysis" (or "multiplicity").

3.2. Singularity

The usual singular/multiple contrast is between colors and tones:

> Color mixtures are perceived as singular (synthesis) whereas tone mixtures are perceived as more than one (analysis), as shown by Helmholtz and Mach. (Erickson and Covey 1980: 527)

And:

> Auditory mixtures provide the classic example of analysis. A high note and low note played simultaneously on a piano each can be analysed out of the mix and perceived separately .... Color mixtures provide the classic example of synthesis. If we mix red and green lights, the resulting color we see is yellow .... Red and green cannot be analyzed out, because the two lights have been synthesized into something else. (Wolfe et al. 2006: 325)

A sound may be perceived as "as more than one"—as comprising two simultaneous tones, for instance. In this intuitive sense, colors are *always* perceived "as one" or as singular—even "binary" hues such as orange and purple. Despite the fact that both quotations suggest this observation is closely connected with claims about the result of physically combining stimuli, it isn't. As it happens, red and blue pigments (and red and blue lights) typically combine to form purple pigments and lights. That is perfectly consistent with the singularity of purple.[16]

In fact, we have already met the singular/multiple distinction twice. First, it seems to be the distinction Locke was getting at between simple and complex ideas: a color, unlike a two-tone sound, "contains in it nothing but *one uniform Appearance*, or Conception in the mind, and is not distinguishable into different Ideas" (see section 1.2 above).

Second, the singular/multiple distinction is (or so we suggest) none other than the distinction between non-conjunctive and conjunctive representation. Colors are singular in the sense that a colored object is never represented as having a conjunction of colors. Tastes, on the other hand, are arguably sometimes multiple, not singular: chocolate, perhaps, is represented as both bitter and sweet. Thus the four taste model could as well have been stated in terms of singularity, as indeed Erickson sometimes does: bitterness, sweetness, sourness and saltiness are all singular, and all other tastes are multiple.[17]

Perhaps the four tastes model or something like it is correct—we will briefly investigate this in section 5. However, the present discussion makes it evident that nothing like this model holds for color—there are no "multiple colors", as there are arguably "multiple tastes". But then what is the right account of the structure of color appearance?

4. Color

Recall the quotation from Hardin at the start of this paper. Binary hues, such as orange and purple, have the unique or elementary hues as "constituents"; they are "blends of pairs of the elementary hues". Obviously this cannot be understood as the claim that the four unique hues are basic qualities in the sense just explained. For if they were, then an object that looks purple, for example, would be represented as both red and blue, which

is mistaken twice over. First, to look purple is not to be represented as having quality X and (distinct) quality Y. Second, even if it were, red and blue are not the right candidates for X and Y—purple objects are neither red nor blue.

In fact, it is somewhat more natural to say—as Hardin does elsewhere—that "purple seems to have both reddish and bluish constituents in it" (Hardin 1988: 29). Although purple objects are neither red nor blue, they are reddish and bluish. Turquoise and blue objects are also bluish; orange and red objects are also reddish. "Bluishness" thus spans the hue circle from turquoise to blue to purple, and "reddishness" from purple to red to orange. To say that reddishness and bluishness are the basic colors from which purple is derived seems *almost* right—but not quite, since purple is singular. In particular, although purple objects are reddish and bluish, they are not represented as such.

The representational account of basic qualities is just a specific version of a more general representational approach to explaining the structure of appearance. The structure of taste appearances is (arguably) explained by a certain predicational complexity in the content of gustatory experience, specifically (a simple sort of) conjunction. We have just seen that this is not the right tool to explain the structure of color appearance, but perhaps another sort of predicational complexity will do the trick.[18]

4.1. Basic hue magnitudes

Begin with two observations. First, it doesn't seem exactly right to say that singularity and non-conjunctive representation are equivalent. Here is a (somewhat imperfect) example: a glass might look two-thirds full of water *and* one third full of oil, but this is better classed as a case of singularity, not multiplicity. To look two-thirds full of water *and* one third full of oil is not like looking red *and* round. The difference is that the conjuncts in the first case both concern the same feature, namely the contents of the glass. In contrast, the conjuncts in the second case have no such commonality. To say that something is red is not thereby to constrain its shape, but to say that the glass is two thirds full of water is to constrain the proportion of oil it contains—it can't contain more than a third.

The second observation is that, in some intuitive sense, a purple object can be more bluish than reddish, or more reddish than bluish. In fact, this can even be quantified, as experiments by Sternheim and Boynton (1966) show: a purple object (again in some intuitive sense) might be around 80% bluish and 20% reddish.[19]

These two observations suggest an account of the representation of colors that explains the structure of color appearance, while respecting the fact that colors are singular.[20] Suppose that are four "hue magnitudes", R,

Y, B, and G, which come in degrees like length and temperature. To have some degree or other of the R magnitude is to be reddish; to have some degree or other of the B magnitude is to be bluish, and similarly with the "yellowish" magnitude Y and the "greenish" magnitude G. When one sees an object as purple it is represented as reddish to a degree that is roughly 50% of its *total hue*, the sum of its degrees of all the hue magnitudes, and bluish to the remaining degree.[21] When one sees an object as unique red it is represented as having a degree of reddishness that is 100% of its total hue. Purple's similarity to red is explained by the fact that reddishness figures in the representation of both. Likewise with purple's similarity to blue: here the common representational element is bluishness. Although a purple object is represented as (say) 60% bluish *and* 40% reddish, these conjuncts both concern the same feature of the object, namely its total hue. Thus purple's singularity is accommodated.

4.2. Modality

The account just sketched not only accommodates singularity. Helmholtz noticed that sensible qualities occur in families or *modalities*. Orange and yellow are members of single modality while orange and sourness are members of separate modalities. A modality is united by similarities among its members, while there is no similarity between qualities belonging to different modalities. As Helmholtz explains:

> Among the different kinds of sense perceptions there occur two different types of distinction. The most fundamental is the distinction among sensations that belong to the different senses, as among blue, sweet, warm, and high-pitched. I have permitted myself to call this a distinction in the modality of sensation. It is so fundamental that it excludes any transition from one to the other, from any relation of greater or lesser similarity. For example, it simply cannot be an issue as to whether sweet may be similar to blue or red. By contrast, the second type of distinction, which is less fundamental, is that among different sensations of the same sense. To it I restrict the designation of a difference in quality .... A transition and comparison is possible within each such circle. We can move from blue through violet and carmine red into scarlet red; and, for example, assert that yellow may be more similar to orange red than to blue (Helmholtz 1995/1878: 345).[22]

Although qualities that are members of the same modality may all be perceptible by the same mechanism, Helmholtz draws the distinction in phenomenological rather than physiological terms. We should then expect a representational explanation of why the colors form a modality—in particular, a common element to the representation of every color. And, according to the hue magnitude account just sketched, there *is* such a common element. The representation of unique blue and unique red, for

example, both concern the same feature, namely *total hue*. It is this crucial feature of the representation of colors that binds them together into a single modality.

5. Taste

We now return to the issue of whether there are basic tastes. Drawing on the previous section, we can divide basic tastes models into two kinds, depending on whether the tastes form a Helmholtzian modality. And if basic tastes models are incorrect, there is at least one alternative explanation of the structure of tastes, namely one roughly parallel to the hue magnitude account.

Interestingly, all three possibilities are represented in the literature on basic tastes. Early in the scientific study of taste (1891) we find the Swedish physiologist Hjalmar Öhrwall describing each of the basic tastes as forming a modality on the grounds that there are no relations of similarity between them. Öhrwall denies that tastes form a continuum and then goes on to explain:

> Comparing taste sensations with sight, one could express this difference by stating that the taste sensation spectrum is not a continuum, but that it is composed of a small number of widely spaced lines. These lines cannot even be arranged in a specified order (indeed, perhaps because there are no transition points). Unlike colors, simple taste sensations cannot be mixed to form new sensations, which in turn cannot be divided into their simple component parts.... However one might mix, one never gets a new taste, and it is even less possible to get something which would correspond to white which, so to speak, does not have quality. The mixture tastes equally salty and sour, or only salty or only sour, etc. (Erickson 1984: 107)

After quoting the passage from Helmholtz in the previous section, Öhrwall continues:

> According to this theory, the different types of taste must undoubtedly be regarded as being different modalities because transition and comparison is not possible between them. Just as one cannot say whether sweet is more like red or blue, one cannot determine whether it is more like salty or sour; and one cannot approximate or go from sweet, through any modification of sweet, to a sour... or bitter taste. (108)

On Öhrwall's view, calling sweetness and sourness 'tastes' merely indicates that they are both detected by the tongue—they have nothing more in common. To taste something as sweet and sour is like seeing something as red and round, perceiving it as having completely unrelated properties.

Alternatively, taste might be compared to the audible qualities. On this version of the basic tastes model, sweetness is similar to sourness (albeit in a very general respect), somewhat as a high pitched-tone is similar to a low-pitched one. And although many modern discussions are unclear on whether or not the basic tastes form a Helmholtzian modality, the analogy with sound is pervasive (Halpern 1997: 87–93).

And, finally, there is the rejection of the basic tastes model and the comparison with color. In 1916 we find the German physiologist Hans Henning, originator of the famous taste tetrahedron, claiming that the tastes form a similarity series and thus constitute a single modality in Helmholtz's sense: "The nature of the psychic quality series [of taste] is such that in progressing along the series, similarities change although every member of the series is a single sensation" (Erickson 1984: 112). Moreover, according to Henning, the traditional four basic tastes play a role somewhat similar to Hering's four unique hues: "The experience of tasting a simple substance in transition between salty and sweet is totally different sensorily than a taste mixture of salt and sugar. Similarly . . . it is equally impossible to see the basic orange color as yellow one time and only as red another" (113). Views like Henning's have had prominent recent defenders, most notably Erickson (Erickson and Covey 1980, Erickson 2008).

Which of these positions is supported by the evidence? One difficulty in interpreting the empirical literature is that clear distinctions are not always drawn as to exactly what claim is being evaluated. The basic tastes theory is often described as embodying claims about the receptors involved in taste, the type of post-receptoral processing found in taste, plus the phenomenology of taste experience. Sometimes added to the package (or claimed to be derived from it) is a claim about the number of taste primaries. Any evidence that undermines any of these claims is then interpreted as undermining all the components of the theory. For example, discussions of the existence of basic tastes often involve discussion of whether any taste can be matched by an appropriate mixture of four (or five) taste primaries. The data on this question are confusing and in any event clearly irrelevant to our phenomenological question.[23] For color, three primaries are enough to match any stimulus but, as we have seen, this is perfectly compatible with the nonexistence of basic colors.[24]

More relevant is research showing that some groups of simple tastants are indistinguishable if appropriately adjusted for concentration. For example, solutions of several common sugars (sucrose, fructose, glucose and maltose) all are indiscriminable at appropriate concentrations (Breslin et al. 1996). This suggests that for this range of tastants there aren't multiple forms of sweetness, but it does not settle the issue of basicness.

In an attempt to address the question directly, Erickson and Covey (1980) elicited judgments of singularity from their subjects for a range of stimuli. The results were equivocal. For example, more than 80% judged solutions of

NaCl and sucrose to be singular, while 60% judged a mixture of the two to be "more-than-one", which suggests that most subjects tasted it as both salty and sweet. On the other hand, a mixture of NaCl and HCl was judged to be about as singular as its components. These results should be treated with caution, however, for at least two reasons. First, some subjects might have misinterpreted the instructions, which were couched in unfamiliar vocabulary ("subjects were simply asked to indicate whether the stimuli were "singular" or "more-than-one""(527)). Second, there was significant variation between subjects in judged singularity among the pure tastants themselves. The upshot is that both proponents and opponents of basic tastes can find support for their views in the existing literature.[25]

Although the empirical literature is inconclusive there is some plausibility to the phenomenological version of the basic taste theory. In any event, its mere possibility illustrates that there are different ways in which the sensible qualities might be represented. If lemonade tastes sweet and sour, then taste is (at least in some cases) an analytic sense, and sweetness and sourness are both basic tastes. And if there are basic tastes, then there is a fundamental difference between the perceptual representation of tastes and the representation of colors.

6. Conclusion

One way of putting our main conclusion is that the structure of appearance cannot be explained simply in terms of the sensible qualities themselves—what matters is how those qualities are represented. That might suggest some sort of Kantian picture, on which the structure of appearance is imposed by the structure of our minds. On this view, the similarities and differences between the colors and between tastes are somehow "in us", not in the things themselves. Although the sense in which the structure of appearance is "in us" is obscure, the Kantian picture has a certain hold on the imagination. For example, in a recent *New York Times* magazine cover article Steven Pinker writes that "The qualitative difference between red and green", is a "[product] of our biological makeup and [has] no objective counterpart in the world" (2008: 58).

However, the Kantian picture—whatever it may be, exactly—is no part of the account offered here. On the representational view, the structure of appearance is imposed by the structure of the propositional content of perceptual experience, by the way the world is perceptually represented as being. And for all that has been said, there is no reason to deny that the world *is* that way—that tomatoes have certain proportions of hue magnitudes and that sweet-and-sour candy is (assuming the basic tastes model) both sweet and sour. More importantly, even if nothing is colored or tasty, this leaves the similarities and differences between the colors and the tastes unaffected.

The similarity between the (apparent) taste of lemonade and the (apparent) taste of chocolate is (again assuming the basic tastes model) due to sweetness being a common component of the propositions that are the contents of the two sorts of gustatory experiences—to a first approximation, the conjunctive proposition that this is sweet and sour, and the conjunctive proposition that this is bitter and sweet. And although it is a contingent fact of our biological makeup that lemonade and chocolate taste that way, the similarity between the ways they in fact taste has nothing to do with us.[26]

Notes

1. It might be objected that we are conflating properties and qualities. According to Johnston, "the philosophy of color . . . has ignored a basic distinction, which can be illustrated by the difference between vermillion, the quality, and the property of being vermillion" (Johnston 2007: 262). He gives a number of reasons for making this distinction, one of which turns on the fact that the expressions 'vermillion' and '(the property) being vermillion' are not intersubstitutable: "'(The property of) being vermillion is the color of my true love's hair' is just infelicitous" (262). Certainly 'being vermillion' and 'vermillion' have different distributions, but since 'being vermillion' is a gerund phrase, there is presumably a syntactic explanation of this, consistent with 'being vermilion' and 'vermilion' having same semantic value, namely the property of being vermillion. (For a related issue about whether 'that'-clauses have propositions as their semantic values, see King 2007: 137–63.) The rest of Johnston's case for the quality/property distinction needs more discussion, but in this paper we will assume that properties and qualities are the same.
2. On one view, the proper objects of olfaction are not items like eggs but instead are portions of gas; likewise perhaps the proper objects of gustation are portions of solids or liquids. This complication will not matter here.
3. The terminology of 'basic colors' is not standard, but is sometimes used; see, for example, Goldstein 2002: 189.
4. The conception of four unique hues arguably goes back to the fourteenth century (Pridmore 2006).
5. The basic tastes model covers much more than the issues concerning the structure of tastes that are our concern here. It also incorporates claims about the physiology of the taste system and the existence of specifiable substances that activate a single taste mechanism and result in the pure experience of one of the four (or five) basic tastes (Halpern 2002: 654–5).
6. Separating the non-taste components of flavor is not simple. Although odors may be readily distinguished from tastes by plugging the nose, and presumably a so-called "oily taste" is really a matter of texture, there is continuing debate about whether any tastes are "metallic" (Stevens et al. 2006). There is also a complicated relationship between taste, flavor, and palatability (hedonic value). For a discussion of this relationship in the case of the putative fifth taste, umami, see Halpern 2000.
7. Some of the material from the following section is adapted from Byrne Forthcoming.

8. Shoemaker (1990) calls such a position "literal projectivism".
9. See also Schiffman and Erickson 1980: 111.
10. An alternative and equally sinister interpretation is that Goldstein's "sensations" are something like sense data, in which case he is identifying taste qualities with *sensational* qualities (see the following section).
11. For some of the interpretive controversy, see Chappell et al. 2004.
12. For an English translation of some of van Skramlik's results, see Erickson 1984b: 119–25.
13. Hering, as might be expected, was especially clear on this point (1920/1964: 3–4).
14. Failure to make this distinction clearly for taste has led to "a long-standing ambiguity in the taste literature regarding the term 'basic tastes'" (Breslin 2001: 442).
15. In the case of taste it has been a common practice to classify receptors (and post-receptoral neurons as well) in terms of the tastant that provokes the greatest response. This gives rise to a coordinated classification of tastants and taste receptors. For example, sucrose is the best stimulus for some taste-receptors. On the receptor-based conception it is thus a basic taste stimulus, and the receptors it stimulates are "sucrose-best" receptors. A useful discussion is in Halpern 2002: 654–5.
16. Explaining the singular/multiple distinction by contrasting colors and tones is not entirely happy, because (arguably) the example of a high and low note mixture involves multiple particular sounds having different auditory properties, not the same sound having multiple auditory properties. And if the high and low notes are different sounds, then a comparable color example would be perceiving a mixture of red and green marbles—in which case there is no contrast with audition, because in this case red and green *can* be "analysed out". (On the ontology and individuation of sounds, see O'Callaghan 2007.)
17. See, in particular, Erickson 1982. Erickson's view is actually not this straightforward because he repeatedly claims (for instance in the paper cited) that "there is no clear definition of what a primary [basic] taste is" (57). See also the quotation in the introduction.
18. For the point that the singularity of color should not be confused with (putting it in our terms) the simplicity of the representation of color, see Westphal 1984.
19. Subjects were actually asked to estimate the proportion of "blue", "red", etc., in the stimulus.
20. We have given this account before (Byrne and Hilbert 2003), although without mentioning the fact that it (arguably) respects the singularity of colors, or explains why the colors form a modality (see the next section).
21. There is an additional constraint on the representation of total hue derived from the fact that the four hue magnitudes fall into two opponent-pairs: red and green, blue and yellow. If the proportion of reddishness in the total hue is non-zero then the proportion of greenishhness is zero and vice versa; similarly for bluishness and yellowishness.
22. Note that Helmholtz takes sensations to be the bearers of color and taste (cf. section 1.1 above).
23. For a brief review see Halpern 1997: 95–6. The experimental basis for these claims is surprisingly thin. As Halpern points out one problem is that it's not clear exactly what is and isn't to be included within the realm of taste.

24. Even for color this claim about matching involves some significant idealization. It is only strictly true for small stimuli presented on a uniform and homogenous background. Achieving a match in some cases involves adding one of the primaries to the light to be matched rather than to the other two primaries. It is interesting to observe that if the methods found in the taste literature were applied to color vision then the same sorts of controversies would arise. Experiments done under different conditions would lead to different results and without the appropriate idealizing assumptions perfect matches would not be found for some color stimuli using some sets of primaries.
25. For helpful discussion see Halpern 1997: 97–102.
26. Thanks to audiences at Georgia State University, Washington Unversity, and Ohio State University for suffering through early versions and providing helpful feedback.

References

Armstrong, D. M. 1978. A Theory of Universals: Universals and Scientific Realism Volume II. Cambridge: Cambridge University Press.

Boring, E. G. 1933. The Physical Dimensions of Consciousness. New York: Century.

Breslin, P. A. S. 2001. Human gustation and flavour. Flavor and Fragrance Journal 16: 439–56.

Breslin, P. A. S., G. K. Beauchamp, and E. N. Pugh. 1996. Monogeusia for fructose, glucose, sucrose, and maltose. Perception & Psychophysics 58: 327–41.

Byrne, A. Forthcoming. Sensory qualities, sensible qualities, sensational qualities. The Oxford Handbook of Philosophy of Mind, ed. B. McLaughlin and A. Beckermann. Oxford: Oxford University Press.

Byrne, A., and D. R. Hilbert. 2003. Color realism and color science. Behavioral and Brain Sciences 26: 3–21.

Chappell, V., M. B. Bolton, T. M. Lennnon, L. Newman, G. A. J. Rogers, and G. Yaffe. 2004. Symposium: Locke and the veil of perception. Pacific Philosophical Quarterly 85: 243–633.

Delwiche, J. 1996. Are there 'basic' tastes? Trends in Food Science & Technology 7: 411–5.

Erickson, R. P. 1982. Studies on the perception of taste: do primaries exist? Physiology and Behavior 28: 57–62.

——. 1984. Öhrwall, Henning and von Skramlik; the foundations of the four primary position in taste. Neuroscience & Biobehavioral Reviews 8: 105–27.

——. 2008. A study of the science of taste: on the origins and influence of core ideas. Behavioral and Brain Sciences 31: 59–75.

Erickson, R. P., and E. Covey. 1980. On the singularity of taste sensations: what is a taste primary? Physiology & Behavior 25: 527–33.

Goldstein, E. B. 2002. Sensation and Perception. Sixth ed. Pacific Grove, CA: Brooks/Cole.

Halpern, B. P. 1997. Psychophysics of taste. Tasting and Smelling, ed. G. K. Beauchamp and L. Bartoshuk. New York: Academic Press.

——. 2000. Glutamate and the flavor of foods. Journal of Nutrition 130: 910S–4S.

——. 2002. Taste. Steven's Handbook of Experimental Psychology: Vol. 1, Sensation and Perception, ed. H. Pashler and S. Yantis. New York: John Wiley & Sons.

Hardin, C. L. 1988. Color for Philosophers. Hackett.

——. 2008. Color qualities and the physical world. The Case for Qualia, ed. E. Wright. Cambridge, MA: MIT Press.

Hayek, F. A. 1952. The Sensory Order. Chicago: University of Chicago Press.

Helmholtz, H. v. 1878/1995. The facts in perception. Herman von Helmholtz: Science and Culture: Popular and Philosophical Essays, ed. D. Cahan. Chicago: University of Chicago Press.

Hering, E. 1920/1964. Outlines of a Theory of the Light Sense. Translated by L. M. Hurvich and D. Jameson. Cambridge, MA: Harvard University Press.

Johnston, M. 2007. Objective mind and the objectivity of our minds. Philosophy and Phenomenological Research 75: 233–68.

King, J. C. 2007. The Nature and Structure of Content. Oxford: Oxford University Press.

Krulwich, R. 2007. Sweet, sour, salty, bitter... and umami. Morning Edition, NPR (November 5), http://www.npr.org/templates/story/story.phP&Quest;storyId=15819485&ft=1&f=1032.

Kurihara, K., and M. Kashiwayanagi. 2000. Physiological studies on umami taste. Journal of Nutrition 130: 931S–34S.

Locke, J. 1689/1975. An Essay Concerning Human Understanding. Oxford: Oxford University Press.

O'Callaghan, C. 2007. Sounds. Oxford: Oxford University Press.

Pinker, S. 2008. The moral instinct. New York Times Magazine 1.13.08: 32–58.

Pridmore, R. W. 2006. 14th century example of the four unique hues. Color Research and Application 31: 364–5.

Schiffman, S. S., and R. P. Erickson. 1980. The issue of primary tastes versus a taste continuum. Neuroscience and Biobehavioral Reviews 4: 109–17.

Shoemaker, S. 1990. Qualities and qualia: what's in the mind? Philosophy and Phenomenological Research 50: 507–24.

Siegel, S. 2005. The contents of perception. The Stanford Encyclopedia of Philosophy (Summer 2005 Edition) http://plato.stanford.edu/archives/sum2005/entries/perception-contents.

Snow, B. E., and H. B. Froehlich. 1920. The Theory and Practice of Color. New York: Prang.

Sternheim, C. E., and R. M. Boynton. 1966. Uniqueness of perceived hues investigated with a continuous judgmental technique. Journal of Experimental Psychology 72: 770–6.

Stevens, D. A., R. F. Smith, and H. T. Lawless. 2006. Multidimensional scaling of ferrous sulfate and basic tastes. Physiology & Behavior 87: 272–9.

Westphal, J. 1984. The complexity of quality. Philosophy 59: 457–71.

Wolfe, J. M., K. R. Kluender, D. M. Levi, L. M. Bartoshuk, R. S. Herz, R. L. Klatzy, and S. J. Lederman. 2006. Sensation & Perception. Sunderland, MA: Sinauer Associates.

Young, T. 1802. On the theory of light and colours. Philosophical Transactions of the Royal Society of London 92: 12–48.