

Commentary on Erickson, BBS

Criteria for basic tastes and other sensory primaries

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Abstract

Primary, or basic, colors have been discussed for centuries. Over time, three criteria have emerged on their behalf – their physical mixture yielding all other spectral colors, the physiological attunement of receptors or pathways to particular wavelengths, and the etymological history of the color term. These criteria can be applied usefully to taste to clarify issues.

Erickson argues against salt, sweet, bitter, and sour as “basic” tastes. His control tests with proline, lysine, etc, are particularly useful, but his empirical facts are also not surprising. What Erickson and I find surprising is that a notion of four pure, labeled-line, basic tastes would have survived so long given Pfaffman’s (1941) early support for what is now called across-fiber patterning. More broadly, why does the notion of basic sensations persist in any modality?

The larger history across the sensory modalities offers some insight. At least since Boyle (1663/1999), basic colors were called *primaries*, and this idea appeared perception textbooks up to the 1980s. But the terminology was confusing, since Locke and Boyle’s distinction of primary (objective) and secondary (subjective) “qualities” (see Herrnstein & Boring, 1965, pp. 14-17) made some secondary qualities into primary sensations. Thankfully, the notion of color primaries disappeared from textbooks. Nonetheless, *basic* colors remained.

But talk of primaries, if by another name, is unavoidable. Primaries are steeped in history and inveigle theory. Historically, there are at least three criteria for primaryness. Consider color. Young, building on Newton, argued that three widely spaced colors could serve as primary colors and generate (almost) all chromatic secondary colors. Thus, (a) *physical mixture* became the first, and oldest, criterion for determining what a basic sensation (a primary) is versus what can only be derived from them (a secondary). Erickson tests a

correlate – singularity (primaries should be singular) – and finds little evidence for this in taste. But there isn't much evidence supporting its diagnosticity in color either.

The next criterion came from Johannes Müller (see Herrnstein & Boring, 1965, pp. 26-33), who popularized the idea now known as the labeled line. Let us call this criterion (b) *physiological attunement*. That is, certain neural pathways are uniquely attuned to certain physical states – particular chemicals, chromatic frequencies, whatever. Ignoring Hering's evidence for four primary colors, these two concepts – physical mixture and physiological attunement – seemed congenially aligned. Erickson reviews the attunement evidence for basic tastes, but finds the area insufficiently unmotivated.

The third criterion comes from language. Call it (c) *cultural salience*. This is really the only one in which the tetrad of salt, sweet, bitter, and sour makes sense. Erickson notes that most languages have such words, but he doesn't pursue a deeper cultural context.

Back to color: The basic English color terms are red, yellow, green, blue, brown, black, gray, and white (Berlin & Kay, 1969). Critically, their etymology is lost in the prehistory of the language. They are not related to any object. All other color terms are borrowed from objects – orange from the fruit, violet and pink from their respective flowers, indigo from a plant. Such nonbasic color terms are legion – silver, gold, navy, turquoise, mauve, khaki, burgundy, chartreuse, olive, lavender.

Back to taste: Salt, sweet, bitter, and sour are primaries by this definition in English (all are Teutonic), and surely in very many other languages. The reason is that these terms are enwrapped in the needs and desires of members of many cultures, and have remained so for a long time. Consider:

Salt licks were always highly prized locations for human beings, and so named (e.g. Salzburg, Alsace, and any English town ending in “wich”). Salt has served as money, it featured in Norse mythology and in the Bible, and salt taxes spurred Gandhi's fasts (Kurlansky, 2002). All of this would seem to make salt salient across a wide range of cultures.

Sweet has always been linked with ripe fruit, and over the last four centuries with cane sugar and sucrose. The growth of cane sugar consumption was astonishing. Mintz (1985, pp. 5-6) noted that in England cane sugar went from a nobleman's privilege in 1650 to supplying one fifth of the calories of the English diet by 1900 – about the level for US teenagers today. How could sweet not be a cultural primary?

Bitter is a term that has been associated with beer (as in a pint of ...) for many centuries. Until the 19th century, beer was the universal beverage in Northern Europe, particularly among lower classes. Beer soup was a typical breakfast beverage, and the average daily beer consumption was three liters (man, woman, and child; Schivelbusch, 1992). From the 17th century chocolate and coffee joined the bitter mix, both soon to be sweetened with cane sugar. Like sugar and at about the same time, chocolate and coffee entered into Western culture as a noble treat, unaffordable to all but the few, only to become

necessities for all nearly two centuries later. Indeed, one could argue that salt, sweet (cane sugar), and bitter (chocolate and coffee), along with spice tastes, drove the earliest successes of globalized markets.

Sour is intimately associated with acids and fermentation. All cultures have fermented (soured) foods – milk (to make yoghurt), cereals (to make bread), maize, cassava, etc. Fermentation and salting were the earliest food preservative processes used by humankind. Such a great gain for nutrition would remain salient in a culture for a long time.

Other basic tastes by this criterion? Acrid, no, defined as bitter; fat, no, derived from fed (fatted = well fed); metallic, no; umami, not in the West; water, likely not (salt:salty \neq water:watery). So Erickson is right – the evidence from (a) mixture and (b) physiological response does not favor any basic tastes. But the evidence for (c) the cultural salience of four remains strong.

Some colors meet all three basic criteria, although caveats are needed. The best green wavelength to mix with a given red to produce the best yellow is not the green that maximally triggers the middle-wavelength receptor, and is not the green that is the prototype on a Munsell color chart. As Erickson notes, logic should drive our science, but depending on whether one's frame of reference is the logic of physical mixture, of receptor physiology, or of language and culture, one will get differing results. To keep these separate is to advance the science on all fronts.

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