

One might dispute the analogy between reflectance types and AL types by arguing that the former and not the latter are perceptually detectable. The fact that they are actually detectable is of course dependent on the existence of the relevant sorts of color perceivers. AL types are in principle perceivable, and indeed we could extend our imagined scenario so that Adam constructs a set of robots to search for and collect AL type objects using sensors and post-sensor analyzers that reliably produced AL representations when and only when an AL type object was present. Given the right sort of story, it would be fair to say that AL types were perceivable relative to the robots. Thus, in terms of perceptibility, AL types differ from reflectance types at most in *actual, in practice* perceptibility, which does not seem to undercut the analogy to any significant degree.

Let me mention one other difficulty which cannot be developed here at any length. B&H are concerned with experiential content and the properties that objects appear to have in perceptual experience. Their focus is on the distal causes of the relevant experiences and thus it is not surprising that they appear sympathetic to covariational accounts of content. However, mental content, including that associated with perceptual experience, is unlikely to be determined by input relations alone. Surely two creatures – two perceivers – could have detectors that detected exactly the same features of the external environment but which appeared to them quite differently. To one creature the detection of those features might make the relevant object appear nutritious and food-like, while to the other those same features would appear as noxious. The same distal tracking conditions would hold, but the content of the perceptual experience would surely differ.

Some may find it difficult to accept that objects can look nutritious or noxious, as opposed to being inferred to be such. I have no such difficulty but if you do, then shift from vision to olfaction, where it seems obvious that such properties can be smelled and where two creatures might differ drastically in the content of their perceptual experience despite the exact coincidence of their tracking and detection profiles. Insofar as perceptual content is not determined solely by input relations, the content of color experience may be determined by inner factors over and above the relevant facts about their distal causes on which B&H focus.

## Confusion of sensations and their physical correlates

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**Abstract:** The authors favor a “color realism” theory that considers colors to be physical properties residing in objects that reflect, emit, or transmit light. It is opposed to the theory that colors are sensations or visual experiences. This commentary suggests that both theories are correct, and that context usually indicates which of these dual aspects is being considered.

As the authors recognize, their position that colors are physical properties of objects, rather than the products of sensory evaluation of optical stimuli, is not held by the majority of color scientists. There is good reason for those doing experimental work in vision research to consider that color does not reside in objects or light rays, but rather in the visual response of color by viewers.

After many experiments with prismatic separation of colors and the nonadditive effects of mixing colored lights and pigments, Newton (1730/1952) also came to the conclusion that colors are sensations or visual experiences rather than physical properties. He stated that,

For the Rays to speak properly are not coloured. . . . so Colours in the Object are nothing but a Disposition to reflect this or that sort of Rays

more copiously than the rest; in the Rays they are nothing but their Dispositions to propagate this or that Motion into the Sensorium, and in the Sensorium they are Sensations of those Motions under the Forms of Colours. (Newton 1730/1952)

Newton also wrote, “And if at any time I speak of Light and Rays as coloured or endued with Colours, I would be understood to speak not philosophically and properly, but grossly, and accordingly to such Conceptions as vulgar People in seeing all these Experiments would be apt to frame.”

I humbly differ from Newton on one point: It is not only “vulgar people” who fail to make the distinction between the stimulus serving as the physical correlate and the sensation it produced. Because it is the vital function of sensory input to allow us to evaluate accurately and respond appropriately to external conditions and events, it is not surprising that aspects of sensation are interpreted in terms of their external physical correlates (see my target article in this journal [Warren 1981] on the physical correlate of sensory intensity).

The distinction between a stimulus and the sensory/perceptual response that it produces applies to hearing, as well. Tones are in some respect similar to color: Changing the frequency or wavelength of the stimulus produces qualitative changes in the sensations that are evoked. According to the “official” definition of tones by the American National Standards Institute (ANSI 1973), a tone is both (1) a “sound wave” and (2) a “sound sensation.” This acknowledgment of dual usage of the term has caused no apparent concern or dissension among those working in audition: They readily make the proper distinction based upon context. As Newton observed, it is much simpler to refer to both a stimulus and its sensory correlate by the same term, while recognizing the distinction; for example, to describe both the pigments of a tomato and its appearance as red, or both the sound of a tuning fork and the pitch it produces as a tone.

In section 1.3.4 entitled “Subjective, objective phenomenal, and physical color,” Byrne & Hilbert (B&H) state that “nothing but confusion can come from using color terms to ‘denote sensations.’” On the contrary, it appears that emphasis on reserving color terms for the inherent “physical” color of objects, such as a ripe tomato, can make understanding color appearance more difficult. An example of such a difficulty is the shift in color observed by Purkinje while seated in a garden in the gathering twilight. He noted that the red flowers seemed black, while the blue flowers seemed gray. We now understand the basis of the “Purkinje shift” in terms of the consequences of switching from cone to rod receptors in the retina. But, if a blue flower appeared gray in the twilight, what was its “true” color at that time? Posed in this manner, the question cannot be answered: Although the physical nature of the flower’s pigments is unchanged, its color to an observer is no longer blue.

In their Abstract, B&H present their view that colors are physical properties of objects and the light they reflect, rather than the subjective responses they produce when being seen. Perhaps it is not necessary to choose between these views. The acousticians may have the right *laissez-faire* approach: Use the same term to describe both the stimulus and the sensory/perceptual response, and allow the context to make it clear which aspect is being considered.