Colors and sensorimotor theory, or what do we really perceive?

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Abstract

Color perception is a scathing expositor of the very different points of view that exist about perception. Besides the philosophical debate about phenomenal experience, colors raise fundamental questions about the contribution of innate and acquired knowledge at the perceptual level, and about the respective weight of neuronal and environmental constraints in learning. Colors provide a specially incisive testbed because they show, in addition to these difficult questions, that the identification of the object of perception is not always a simple matter: psychophysical experiments indeed support the idea that color perception is concerned with the reflecting properties of surfaces[1], rather than with light per se as it is often assumed.

The case of color perception recalls an obvious point: before addressing the way neuronal adaptation takes place in living organisms (be it at the phylogenetical or ontogenetical scale), it is mandatory to question what they adapt to. This is not a simple question because the nervous system can rely to such an extent on indirect cues (spectral composition of light) to estimate the object of perception (surface reflectance), that the presentation of these cues elicits a sensation without the presence of the actual object of perception. It is thus difficult to distinguish, practically and conceptually, what is cue and what is object of perception. Further, to make things even more complicated, it is problematic to satisfy oneself with an understanding of the physical object of perception without taking into account the under-determinacy of the sensorimotor system. For instance, it is obvious that reflecting properties of surfaces concerned with lights outside of the visible spectrum are irrelevant for color perception. But just as important is the fact that there are much less obvious aspects within *the so-called visible spectrum that are irrelevant as a result of the few photopigments that biological organisms possess.*

We will show how to interpret the physical notion of reflectance in a biological way, so that it involves only those aspects of the light/surface interaction that are relevant with respect to a given set of molecular photopigments. From this it will become apparent that surfaces exhibit categorical differences in the way they modify those aspects of light's spectral composition that impact the photopigments of that set. With the three photopigment kinds usually assumed for the human visual system, this biological interpretation predicts eight special colors of three different kinds, corresponding to white/black, red/green/blue and yellow/purple/cyan. These differences will finally be shown to correspond to differences in the sensorimotor contingency[2] that the organism engages in when visually exploring colored surfaces.

References

[1] D. H. Brainard. Color constancy. *The Visual Neurosciences*, 2003.
[2] J. K. O'Regan and A. Noë. A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences*, 24(5), 2001.