

¹Michela Lecca
lecca@fbk.eu
²Oswaldo da Pos
osvaldo.dapos@unipd.it

¹Fondazione Bruno Kessler,
Center for Information and
Communication Technology,
Technologies of Vision, Trento,
Italia;

²Università degli Studi di
Padova, Italia

COLOUMN

Communications and Comments

“Carpet” by Giuseppe Ungaretti

*Every color expands and lays
on the other colors
To be more alone if you look at it.*

“Tappeto”, Giuseppe Ungaretti

*Ogni colore si espande e si adagia
negli altri colori
Per essere più solo se lo guardi.*

“L’Allegria - da Ultime”, Milano 1914/1915

In this column, we would like to propose a novel topic, which could be of interest for the wide community of color scholars: a joint analysis of the human color sensation and perception from the view-points of the phycologists, color scientists, literature scholars and artists. In this framework, many issues have to be addressed, first of all the definition of color sensation and color perception. In the following, we report some general considerations and observations that do not pretend to grasp the complex meaning of color sensation/perception, rather they would like to become a starting point of a more detailed discussion among the color scholars and in particular among the members of the Gruppo del Colore-Associazione Italiana Colore.

Color sensation and perception are considered subsequent processes of human color vision. Nevertheless, these terms are often used improperly, sometimes they are even erroneously employed as synonyms, creating ambiguities and misunderstanding. This confusion is well described by the words of the English philosopher John Stuart Mill (1806 – 1873), which wrote:

“We have a name for the objects which produce in us a certain sensation: the word white. We have a name for the quality of those objects, to which we ascribe the sensation: the name whiteness. But when we speak of the sensation itself [...], language, which adapts itself for the most part only to the common uses of life, has

provided us with no single-worded or immediate designation” [1].

In 1953, the Committee on Colorimetry of the Optical Society of America proposes the following definitions [2]: color sensation is a “mode of mental functioning that is directly associated with stimulation of the organism”, while color perception is a “mode of mental functioning that includes the combination of different sensations and the utilization of past experience in recognizing the objects and facts from which the present stimulation arises.”

More recently, in 1988, Jonathan C. Fish claims [3]:

“Physiologists have shown that light reflected from a dab of paint and entering the retina of the eye results in the discharge of electrical signals that are transmitted to certain regions of the brain causing the occurrence of colour sensations [...]. These sensations are one meaning of the term colour. But since other meanings are commonly given to it, [...] it is sometimes helpful to refer to the sensation of colour as psychological colour”.

Fish clearly states that the expression “color sensation” is often used to indicate both the sensorial stimulation (i.e. color sensation is the result of the propagation of an electrical signal from the eyes to the brain) and its psychophysiological interpretation (i.e. the so-called “psychological color”), dependent on aesthetic issues [4], involving subjective

experience and cultural heritage.

The conception that sensation and perception are two very distinct features of our sensory experience is very diffuse: generally, sensation is considered to be more peripheral, local, fragmented, while perception is more central, organized, and global. This idea has entered and is still popular in the Anglo-Saxon tradition based on Helmholtz's neuropsychological theories [5], stating that visual receptors are linked to the cortex by single neurons, isolated from each other, with the task of bringing peripheral, unmodified information to the cortex. According to Helmholtz, the central neuron system would have the task of organizing and interpreting these data, based on past experiences, hypotheses to be verified, mathematical and statistical knowledge, or even on other sensorial information, e.g. tactile sensation. The conclusions are that in the sensory data, '*local information*' are poor and disorganized, and that perception – which is driven by brain activity – is the full stage of organization where objects, events, meanings, etc. appear. A departure from this theory is proposed by Gibson [6]: he considers the brain activity fundamental for perception, but he states that all the information needed to perception is already present in the stimulation. An alternative approach to this theory is that the organization responsible for the '*last stage perception*' does not necessarily require cognitive additions, but derives from its own nervous system operations, dictated above all by genetic components aimed at creating a perceptive phenomenal world, sufficiently simple to make the resultant behaviour fitting the environment. For instance, following the work of Hering [7], color contrast would be a side-to-side inhibitory neural phenomenon instead of a scientific knowledge of colour blends, as proposed by Helmholtz. Obviously, no interaction between perceptual organization and higher-level cognitive

activity is excluded, but these are not necessary [8]. A modern possibility of saving the distinction between sensation and perception is given by Katz's suggestion [9] of evaluating and comparing differently coloured areas by observing them in '*reduction*' condition. Reduced colours are seen through a hole made on a white (or black) screen: in this case, the term reduction means simplifying the context of each coloured area to make it as simple and uniform as possible so that any observed differences cannot depend on the context.

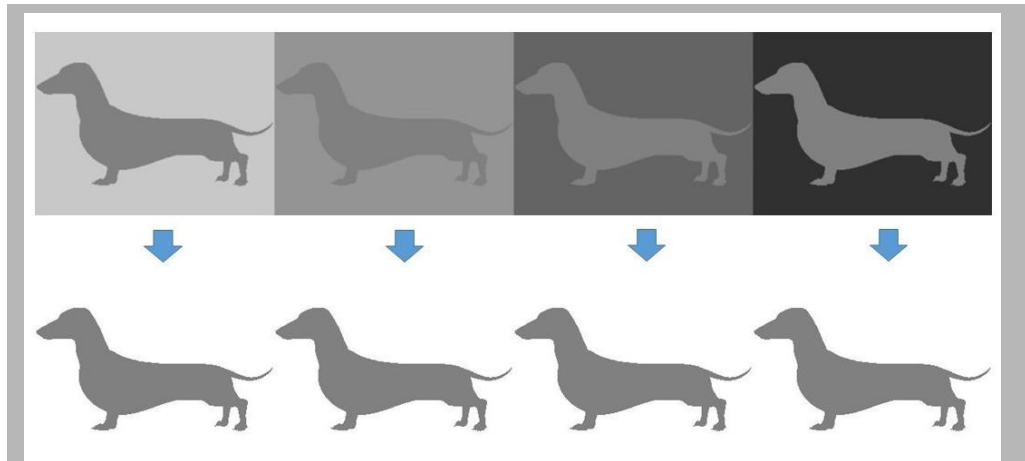
Since anything we observe always appears to be organized in a basic way according to the figure-background categories, even those that we call sensations appear to be somehow organized, and therefore should be called perceptions. The conclusion is that retaining the original distinction of sensation-perception would only make sense of wanting to insist on the original Helmholtzian theory, unless one understands sensation as a perception in a reduced context.

The debate between Anglo-Saxon and American theories opens the problem to determine which features are captured and/or involved in color sensation and in color perception.

Retinex theory by Edwin H. Land and John J. McCann [10], as well as many studies conducted by the artists of the Pointillisme trend and the poetry by Giuseppe Ungaretti (1888-1970) opening this column, consider spatial information as an element highly relevant to color sensation (and thus to color perception). Before Retinex, the human color vision system was supposed to catch colors similarly to a camera, in the sense that the human color sensation derived by observing a point in the scene would correlate with the scene reflectances [11]. Land and McCann conducted a series of experiments that strongly contradicted this belief, showing that human color vision is a spatial, local process, as illustrated by the simultaneous

Figure 1: A color chart of healthy fruits and vegetables, adapted from <http://www.rawayurveda.com/4974/eat-a-rainbow-food-color-chart/>

Figure 1 - Simultaneous contrast: the same dachshund looks differently colored when displayed on background with different grey-level intensity (on top). As matter as fact, the dachshund color is constant (on bottom).



contrast (see Figure 1). This spatial color interaction is well described by the poetry *"Tappeto"* by Ungaretti. He was one of the most important leaders of the literary movement Hermeticism, characterized by a concise, piping style reflecting the prostration state of the human soul after the experience of the First World War and Fascism. In *"Tappeto"*, Ungaretti describes the color sensation derived by observing a carpet. Carpets were for Paul Gauguin the objects most suitable to study color effects, as he wrote in some scattered notes:

"You all, painters, searching for a color technique- let analyze the carpets and find out all you need" [12].

In *"Tappeto"*, the spatial element influencing the color sensation is the distance at which the single color composing the carpet is viewed: in line with Retinex theory, the color sensation at a point changes by enlarging the field of view, thus by changing the locality of the observation with the possible inclusion of more colors. This issue is also at the basis of Impressionism, Pointillism, and Divisionism: these are painting techniques where the objects composing an imaged scene are represented by small brush strokes, with no shading and no color gradient. In particular, Pointillism, introduced in 1880s by the painters Georges Seurat (1859 – 1891) and Paul Signac (1863 –1935), depicts the observed scene as a set of patterns composed by many

small, distinct dots of color. Seurat and Signac were strongly interested in color science, and their point-based painting technique grounds on the human capability of eyes and mind to blend spatially adjacent color spots, sensing novel tones and shades.

On the contrary, Anglo-Saxon theory negates the presence of distance information in color sensation, and supposes that the depth information mainly comes from other sensorial experiences: brain adds more information from other sources, so that what is seen may appear very different upon the way it is observed.

As matter as fact, the considerations reported in this column rely on studies carried out in the 19th and 20th centuries: did the technological novelties of the 21st century change the meaning of color sensation and perception? In case, how? *Could we still say, as Fish, that "colour science and colour art are, for the most part, on separate paths"?* What is the feeling of the Gruppo del Colore? How can its members contribute to clarify the concept of color sensation and perception and to detect the features more relevant to color vision?

Once again, we think that the complex world of color has been not yet fully investigated and more efforts should be done to achieve a better color understanding: now, we give the floor to the reader.

BIBLIOGRAPHY AND NOTES

[1] Mill, John Stuart, "A System of Logic", University Press of the Pacific, Honolulu, 2002, ISBN 1-4102-0252-6

[2] Committee on Colorimetry, Optical Society of America, "The Science of Color" (Crowell, 1953).

[3] Fish, Jonathan C. "Colour as sensation in visual art and in science." *Leonardo* (1981), Vol. 14, N. 2, pp. 89-98.

[4] From its etymology Aesthetics means Sensation, from the greek αἴσθησις: 1. Perception from the senses, feeling, hearing, seeing; 2. Perception by the intellect as well as the senses; 3. That which is perceived: scent; 4. Ability to perceive: discernment; 5. Cognition or discernment of moral discernment in ethical matters (wiktionary.org). Therefore there is no great distance between aesthetics and sensation. Fish, as most people today, not only considers aesthetics as personal experience (sensation) but also expression of cultural heritage.

[5] Pastore, Nicholas. "Selective History of Theories of Visual Perception 1650–1950". Oxford University Press, 1971.

[6] Gibson, James J. 1979. "The Ecological Approach to Visual Perception". Boston: Houghton Mifflin.

[7] Hering, Ewald, (1888), "Über die Theorie des simultanen Kontrastes von Helmholtz", 4. Mitteilung, *Pflueger Archiv*, 43, 1-21.

[8] Dunker Karl, "The influence of past experience upon perceptual properties." *American Journal of Psychology*, 1939, 52, 255-265

[9] Katz, David. 1911. "Die Erscheinungsweisen der Farben und ihre Beeinflussung durch die Individuelle Erfahrung." Leipzig: Barth.

[10] Land, Edwin H., and John J. McCann. "Lightness and retinex theory." *Josa* 61, no. 1 (1971): 1-11.

[11] "Of course the eye behaves in a completely different way from a camera, as it must move continuously to perceive anything, while the camera can catch the light and form a sharp image only if it is steady, condition which eliminates all visual perception." (A. L. Yarbus, *Eye Movements and Vision*. New York: Plenum Press, 1967. Translated from Russian by Basil Haigh. Original Russian edition published for the Institute of Information Transmission of the Academy of Sciences of the USSR by Nauka Press in Moscow in 1965).

[12] Gauguin, Paul. "Diverses Choses (1896-1898)", *Ouvres*, Paris 1974, p.178.