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COLUMN

Communications and Comments

"Psychological colour space is the relational structure among colours colour stimuli that can be found using empirical tasks that assess colour similarities. Colour terms are the lexical categories (which can vary across different ethnolinguistic groups) that are used to label, or describe, colour appearances organized as meaningful partitions of the psychological colour space."

(from: Encyclopedia of Color Science and Technology - https://link.springer.com/referencework/10.1007/978-1-4419-8071-7#toc)

In this column, Prof. Da Pos reports some considerations from the talk he gave during the Munsell 2018 International Congress, held in Boston last June to celebrate the centennial of the Munsell Color System.
Briefly, we remind that Munsell system is a colour space where colours are characterized by hue, lightness and chroma identified by decimal numbers. This colour space, introduced at the beginning of 1900 was officially adopted for researches on soil in 1930, and still today is known and used all over the world.

The talk of Prof. Da Pos was not directly related to technical features of the Munsell system, but it coped with the more general problem of the meaning and the relationships among colour perception, stimuli, and colour terminology, that we partially investigated in our previous column.
In the following, Prof. Da Pos discusses about these concepts and about the need and difficulties to define a colour system capable to capture and relate the three fields of research, often studied separately, colorimetry, perception, and verbal language. A new theory of perception is then highlighted to explain the nature of (perceived) colours and their relationships with the physical world.

As is probably known, last June the Munsell 2018 International Congress was held in Boston to celebrate the centennial of the homonymous colour system. A series of important keynote talks started a week of extremely rich works from both the scientific and the artistic point of view. I was invited, to my great surprise, to keep one of the introductory talks on the subject, expressly requested, 'Colour names, stimulus colour, and their subjective link' [1]. The lecture seems to have fully met the expectations of those who had invited me and the interest of the audience. I asked myself: why this interest in a subject that apparently is only collateral to the Munsell system? The answer I gave is already somehow present in the previous edition of this column, namely that the research in question clarifies the fundamental relationships between physical stimuli, colour perception and verbal language of colour, relationships that are often only implicitly assumed in colour studies or even misunderstood (Figure 1). The assumption of the research is that perception is essentially subjective and conscious, and we can discuss about it not only because we have direct experience, but we can formulate it verbally so as to reflect on it as an object, independent from our subjectivity; secondly, the verbal formulation, although limited, also allows us to communicate the subjectively perceived colour to others.
However, this is not the only way to objectify a subjective impression of

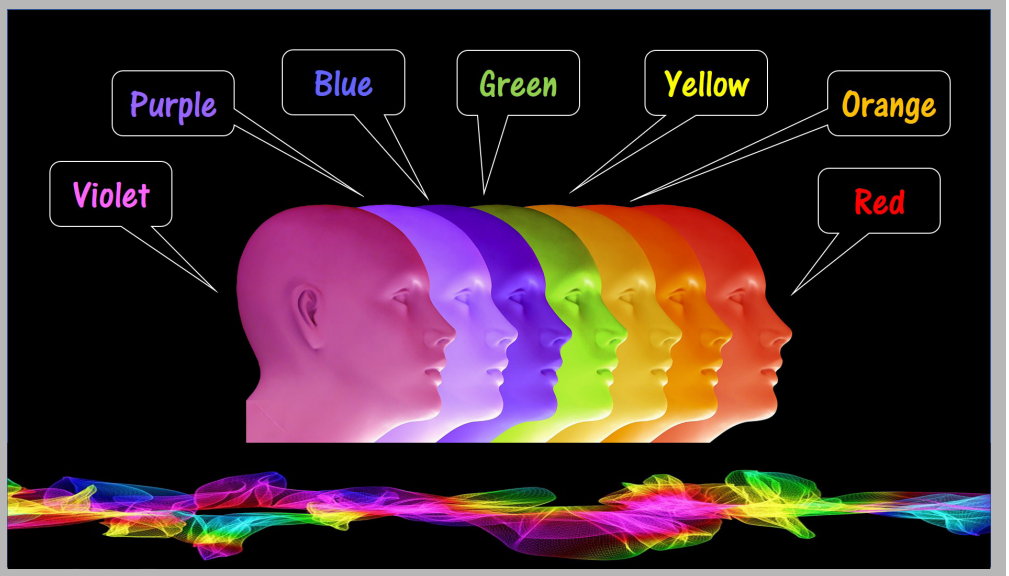

Figure 1 - What's the relationship between color perception, stimuli and terminology? This topic has been discussed by Prof. Da Pos at the Munsell 2018 International Congress, held this year in Boston, USA

colour, because we can also act on the physical world and produce (or eventually choose) a set of stimuli that induce the perception of the same colour in other people. While in the first case, using a verbal term to describe a colour, perception and linguistic formulation are both present in our consciousness, in the second case physical stimulation and perception are not both conscious, but only the perception is. The stimulus colour, on the other hand, can be known only through scientific knowledge, essentially psychophysics and in particular colorimetry. The link between a particular stimulus colour and the corresponding perceived colour, not being conscious, can only be inferred with a limited degree of certainty: is it true that I and the others have the same colour impression when we look, under the same observing conditions, an object? (perceived object, of course).

A recent theory about the relationships presented here has been formulated by D.D. Hoffman et al. in the form of 'Interface Theory of Perception' [2]. The theory essentially says that perception has the function of inducing in the individual a behaviour that is adaptive with respect to the physical environment. This function is accomplished by producing, both in man and in the animal, a phenomenal world, the one that appears around us and of which we are aware: this is an interface between us and the physical environment. Perception therefore has no cognitive purpose, it is not intended to make us know the 'physical reality' as it is, but it is a simplification of our interaction with the environment as it draws from the physical world the information needed to build a subjective world with the essential characteristics to adapt to the environment. It is like the interface of a computer that shows the operator a set of icons on which it acts to accomplish something that affects the physical level, but without knowing its modality. In fact, a person can use the computer effectively without having to know anything about what is beyond what he sees.

Contrary to what happens in animals, in man perception is accessible to rational knowledge, which can therefore not only verbalize what one "sees" in order to be able to reason on it, but can arise questions about its meaning (how it works) to give answers that satisfy his curiosity and his needs. This further step can fix those unavoidable mistakes (in relation to the adequacy of its outcomes as respect to the environment requirements) which perception, being an approximate capability can sometimes encounter: where animal failure brings to death, science and technology increase human fitness.

The colour is therefore an aspect of this interface, and as such it cannot be considered true, but only useful (a yellow icon does not mean at all that the bit sequence 00101001110101 to

which it is pointing is yellow). Long ago I maintained that our colours are pseudo-colours, or false- colours, that is colours artificially produced to make us 'see' something where events otherwise unreachable by our perception are occurring, and therefore allow us to perform the appropriate behaviours.

Ultrasound is a clear example where false colours are used: the colours that this technique shows the observer are not characteristics of the filmed objects or events, clearly unreachable by our perception. On the contrary, they are colours produced by algorithms that experienced engineers and psychologists have decided to attribute to the images displayed on the screen, on the basis of their operational efficacy to achieve specific purposes.

The assumptions of this theory are not entirely new, for example the perception of [chromatic] colour brings an evolutionary advantage to the species that possess it compared to those that do not possess it, despite the colour stimulus be the same for both [3]. In other words, a good software with suitable icons performs better than a poor software with few or inefficient icons, while the physical realm is the same. Colour vision is therefore an enhancement of animal capability to fit the environmental requirements. The gain in fitness is not so absolute as it would be obtainable by a perfect knowledge of the physical world, but it is enough appropriate as its cost is much lower.

The objects and events that occur in the phenomenal world (that is, in the interface man / physical environment) have their own internal logic that can be studied regardless of their link with the underlying physics. This kind of study is performed by the phenomenology of perception, which investigates the characteristics of this world of appearances by finding their reasons in specific relations between elements within it. For example, the impression of transparency that a coloured surface can produce in the observer is explained phenomenologically as follows: the colour of the overlapping area of that surface with another below must be a psychologically intermediate colour (that is it must look like both) between the colour of the overlying surface and that of the underlying surface one [4]. As can be seen, what is treated in the study of perceptive transparency are colours and relationships of similarity between colours, properly quantified but always at a perceptual level. Moreover perceptive transparency does not necessarily derives from physical transparency, although sometimes this happens, but its occurrence only depends on chromatic and configurational properties of the image. This way of interpreting perception in general, and colour perception in particular, as an interface between subject and physical environment, seems to constitute a paradigm shift in current colour science [5]. Many authors are enthusiastic about this, but there is no shortage of criticism, especially regarding some details of the theory [6].

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