

## Colour is Psychology

L. Sivik

Department of Psychology, University of Goteborg, Sweden

Corresponding author: L. Sivik ([L.sivik@ipsoma.se](mailto:L.sivik@ipsoma.se))

### INVITED LECTURE

The Church Father Augustinus said “Everybody knows what Time is – until they are asked to explain it.” Can this be applied on Colour as well? Colours surround us like the air we breathe. But is colour psychology? As both psychologist and colour researcher I will try here with some examples illustrate why I think that colour is psychology altogether.

One of many problems within the realm of colour research refers to language. The word colour can mean pigment, paint, wavelength energy, chromatic surface... In common speech, however, most of us refer to the *sensation* of colour, that is, the *colour perception*. Colour in the latter meaning is perhaps the most correct definition – as colour in fact is an experience that takes place in the head of a living and conscious creature. Outside the brain there is no colour, only physical conditions that may give rise to colour.

*Colour in the proper meaning is perception.* This appears self-evident for most people, but hard to digest for others. Perceptions occur only in nerve cells and for higher species in a brain. This is the case for all our senses – both seeing, hearing, feeling, pain sensations... And all takes place in our psyche. Everything man has noticed and learnt about the world has passed through the various senses into the brain. Also the cognitive elaborations, the thinking and memorising, takes place in brains. Thus everything human is psychology – including colour - which was to be proven.

If pigment, radiation and paint etc. is not colour, what is it then? Well, we certainly don't need to stop calling that colour in daily life. But in many cases, particularly in research, one should be aware of the distinction between perceived colour and what is “out there”. The latter we should call *colour stimulus*, “The father of modern physics”, Isaak Newton<sup>1</sup>, who discovered the radiation and its connection to vision, was very well aware of this distinction which he phrased “*For the rays, to speak properly, are not coloured*”.

Now one can assume that it is not this all-embracing relationship between colour and psychology people in general think of when they hear the concept colour psychology. I guess that many are curious to know whether some colours are better than others, or how colours affect us and similar questions. We all know that colours carry symbolic meanings. Do we have the same associations or are they completely individual? How come that there are so many colour names? I will comment upon some of these topics.

First, however, I want to point out some psychological aspects of colour systematisation – as this was one of the works for which Swedish colour research has been recognised. A question of principle is in which end one should start in creating a colour order system, something that probably was not considered when the CIE-system was invented. Should we start from known physical attributes of colour stimuli, i.e. the radiation, and see what colour sensations they give rise to? Or should we start with the colour as such, the colour perception? In earlier times, when little was known about rods and cones, wave-lengths and energy quanta, people ordered colours the natural way. They didn't know better. Then came the scientific revolution and it was no longer allowed to disregard the physical facts. If the “facts” were not compatible with what one could see with the eyes there was something wrong with the eyes.

One of the most prominent scientists during the 19<sup>th</sup> century, however, was brave enough to defy the experimental facts of his time and trust his eyes and his intellect. Ewald Hering<sup>2</sup> claimed that it is the perceptual end product of the colour vision process that constitutes the true answer. He did not

at all disregard the physical evidence present, e.g. the three-receptor sensitivity maxima. But if this was not congruent with his own introspective findings it only meant that science did not yet know everything. The basic postulate that Hering put forth was that there must be inherent in our psyche specific anchor points, four references for what is pure yellow, red, blue and green, and two for the achromatic, black and white. Another finding was that a colour cannot be both reddish and greenish at the same time, nor simultaneously bluish and yellowish. Of this reason he named his model the Opponent Color Theory. He anticipated that one day the physiologists would prove that he was right, detect the neuronal reconnections between the three-receptor theory and his own structure. This happened eventually, long after Hering's death, and the Opponent Colour Theory started to become accepted.

In Sweden, however, we had some researchers who long before that happened dared walk against the powerful CIE mainstream. Not only did they realise Hering's phenomenological clear-sightedness, they also saw the practical value of having a colour system that the users, in particular architects and designers, could understand and grasp intuitively. Hering had named his system "The Natural Colour System" as he knew it was a natural part of human colour vision.

The early Swedish commitment to Hering's theory started already in the fifties, and when the world was ready for his model the Swedes were ready to present a scientifically elaborated concept and the NCS Colour Atlas<sup>3</sup>. NCS is thus a phenomenological system for ordering of colours as such, i.e. it is perceptually based. All other systems are based on mixings of colour stimuli, subtractive or additive. Or they are hybrids obtained from both perception experiments and stimulus mixing. NCS is today well known and need no further presentation here.

Before I continue with the colour psychology questions I want to point out a distinction that is important here, namely that between general psychology and differential psychology. In general psychology the focus is on psychological behaviours that are common for all humans. Research on colour systems, for example, belongs here. We can assume that we have got our colour vision ability in order to survive on this earth, and then it would be very confusing and contraproductive if we didn't see colours in the same way. If people with normal eyes could not differentiate between red, yellow and green it would be meaningless to put up traffic lights. Differential psychology, on the other hand, is studying differences between groups of people, for example between men and women, between different cultures, or differences between individuals.

Even if the areas of psychology nowadays seem to merge together, I shall give some further examples where colour is an important issue. First into my mind comes, naturally, perception with psychophysics, i.e., the relationship between the physical input and the human response. I guess that a great deal of all the equations and diagrams that are presented during this congress are dealing with this - even if most authors probably would not admit that they are talking colour psychology. All experiments where human subjects report what they see are psychological.

The R&D of NCS was psychology. First it was psychometry, which is the procedure of creating scales of the purely psychic colour phenomena. Then, when we constructed an atlas in order to illustrate the theoretical colour system, we needed to establish the relationships between the psychometry of the perceived colours and the corresponding physical measurements. That is psychophysics. Cognition, thinking and memory are all psychological areas that involve vision. Here we have seen some research, but in my opinion far too little. A neighbouring area is psycholinguistics. Many linguists have been interested in how colour names have developed in various languages and cultures. An early predominant opinion was that colour terms and corresponding colours had occurred randomly and different in different cultures. Therefore it received much attention when Berlin and Kay showed that this was not the case. Their well-known studies<sup>4</sup> showed that all developed languages contain about eleven so-called basic colour terms, and first of all the six elementary colours. There have been many follow-up studies after B&K's and a large number of languages have been examined. Unfortunately both the original study and the followers used as colour stimuli a rather poor two-dimensional chart with Munsell colour chips, without utilizing the three-dimensional

possibility of this system. Thus many important colour areas inside the colour space were excluded<sup>5</sup>. This can be explained by the fact that the linguists were not primarily interested in the colours, but rather in the linguistic comparisons. In Sweden we had a different approach with focus on the distribution of colours for each colour term<sup>6</sup> in the colour space. For a large number of colours we asked the subjects how well each colour was in agreement with the colour name. In this way we could determine focal areas as well as borders for the colour term in question. In mapping the colour space in this way we get “bubbles” for each colour term that clearly show the distribution. When Berlin and Kay’s results came out, with the six elementaries appearing first in all languages, this was a strong support for the opponent theory. In Sweden, however, we were not surprised, we were already convinced of the validity of the theory and found it quite natural that it should be reflected in human languages.

Another area of cognition, to which I myself devoted my first colour studies 35 years ago, was the *connotations* of colours. What meanings do we associate with different colours? This question has interested experimental psychologists since they first appeared in the late 19<sup>th</sup> century and hundreds of investigations have been carried out. But also here the knowledge of the complex multitude of colours and their dimensionality was meager and therefore it has been difficult to guess which colours they actually had used. Which of the thousands of colours that can be called blue did they present? If we assume that it was the blue that we have found represent the focus for people’s conception of blue, we conclude that there have been a substantial concordance between people in different cultures. And the congruence is also considerable with the more thorough investigations we performed in the late 60-ies. In the NCS space we mapped out the distribution of “loadings” regarding a number of adjectival opposite-pairs such as warm-cold, sick-healthy, happy-sorrow, masculine-feminine, exciting-calming and so on. The first computers had already appeared at that time which made it feasible to use factor analysis in order to compress the data and see if there existed some underlying “semantic” dimensions which could be correlated with the perceptual colour dimensions. And this was actually the case. We found four unique factors: Excitation (exciting-calming and similar); Evaluation (beautiful-ugly); Potency (forceful-weak), and warm-cold<sup>7</sup>.

An important difference compared to earlier studies was that we were able to see the influence of all the colour parameters, not only hue (yellow, red, blue and so on), but also whiteness, blackness and chromaticness. This showed astonishingly that the only variables that exhibited significant covariation with hue were those that conformed to the dimension of warm-cold. The colours between orange and red are the warmest and the cold-maximum lies near blue. For other variables of meaning, which generally are believed to be dependent of hue, for example exciting-calming, there were no such variation. Here it was the chromaticness that accounted for the variation and not hue. But from where then comes the general conception that red is exciting and green calming? Probably from the fact that one unconsciously compares a strong red with a weak green. Comparing a strong red with an equally strong green there is no difference in “excitedness”. We performed the studies in several other countries as well and all exhibited a significant concordance – even if we also found some minor differences.

I’d like to point out that investigations of this kind must be interpreted with caution. Not so that the results as such should be doubted, most modern studies have an adequate design and statistical basis. But one cannot always generalise the findings. That a colour is perceived as warm, or is associated with the the word warm, does not mean that a room painted in that colour is literally perceived as warm regarding temperature. And a colour that is associated with the word exciting is certainly not necessarily causing excitement. In order to investigate such effects of colour are required full-scale experiment, which are very difficult to carry out as there are so many environmental factors that influence the outcome. In spite of this such studies have been performed in Sweden, with both verbal reports and physiological measures as dependent variables. But the results have been somewhat contradictory and inconclusive.

In my own opinion our studies of associations and effects of single colours are not as interesting and meaningful as those we made later regarding *colour combinations*. The fact is actually

that colour never appear alone, but always together and in various contexts. Note that two ugly colours can be beautiful together and that two beautiful ones may not match at all. One obvious reason that there are so few good studies of colour combinations is that they are extremely difficult to carry out. Consider that a human eye can distinguish between millions of nuances. How many combinations can you make of these? Even if we decrease the number of colours to a couple of thousands, as in the NCS atlas, the possible number of four-colour combinations are counted in billions - causing experimental design problem.

We figured out, however, that it would be feasible if we first had a descriptive system for colour combinations, a colour combinatoric language by which hypotheses could be formulated and the results described. With ideas and inspiration from our colour legend Anders Hard such a model based on the NCS parameters has been proposed and published<sup>8</sup>. And the studies we have done with the model have been quite promising. As parameters for the combinatoric model we used (as Hering did for his Natural System) such dimensions that people in general use and feel natural. There is the colour interval with attributes such as contrast, colour distance, and relatedness. We have the colour chord, which tells how colours “sound” together. Finally he have colour tuning. The model has three main dimensions, each with three subdimensions. Among the combination experiments we made I will illustrate with a comprehensive result picture from the association studies. It shows e.g. how the “contrastiness” has a strong relevance.

I shall also comment upon a colour psychology area, which I regretfully never had opportunity to investigate. That is colour and personality. There are actually a number of studies that have correlated colour preferences with scores from personality scales, such as Eysenk’s Personality Inventory. There seems to be some evidence that extroverts prefer strong colours while introverts prefer colours with low chromaticness. A prevalent weakness is, again, that the reports give very poor information about which colours that were actually used.

From my viewing-point as both colour researcher and psychotherapist I also will comment on some less house-trained colour devices. Many have perhaps heard of Lüscher’s colour test, it was for a long time used extensively. It has actually been lustfully murdered by a number of competent studies, but like the Bird Phoenix it keeps popping up again. From its manual it seems that the basic knowledge of both colour and personality theory is nonexistent. But the world wants to be deceived, particularly by accompaniment of colours. To the hokus-pokus or charlatan compartment I also count those “colour psychologists” who try to cure depressions and other psychic disorders by putting their patients in coloured rooms, or illuminate them with coloured lamps – instead of referring them to proper psychoterapy by licensed therapists. On the other hand I want to recommend real art therapy, where the patients can express their inner, sometimes unconscious, feelings by means of form and colour, and where educated psychotherapists are present to follow up the psychological material that comes up.

Finally I repeat what is said in the title, colour *is* psychology. Many of us, myself included, are impressed by all the formulas and calculations that the colour phycisists present. But one of the most prominent of these scientists actually once told me that the phycicists in fact had grabbed the simplest colour problems. It is the psychological aspects of colour, he said, that are the difficult ones. I hope, though, that there will be an increasing number of researcher who will continue to attack these difficult questions. I am glad that the AIC since a long time has promoted the psychological aspects. In 1996 a whole AIC conference in my home-town was devoted to this subject<sup>9</sup>. Every colour questions cannot be studied scientifically, many can be answered with common sense. There is no reason, however, neither to diminish the importance of colours, nor ascribe to them too much of weird meanings. .

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