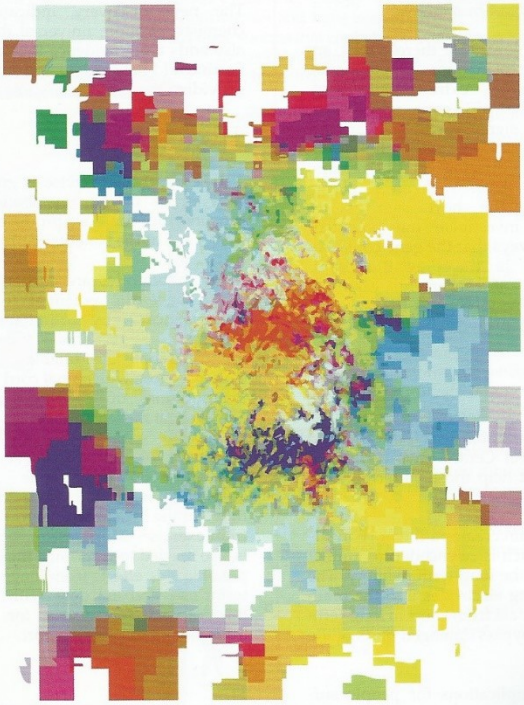
Colour Perception

Do you see the same shade of red as I do?

Colour is such an integral part of our lives that we very rarely question any aspect of it. Grass is green, blood is red and winning rowers are dark blue. Why question truths that seem self-evident?

Well, for one, colour is not actually real; although of course that depends on how we define what 'real' is. Put simply, colour does not exist in that it is not an inherent property of light. This concept is comparable to weight not being an inherent property. For instance, a diamond that weighs 1kg on Earth would weigh 2.36kg on Jupiter due to the stronger gravity experienced on Jupiter's surface.

When light hits the eye, it is focused by the lens onto rod and cone cells in the retina, at the back of the eye. Rod and cone cells are incredibly sensitive to light, with cone cells involved in seeing colour able to detect individual photons. They convert the patterns of photons they receive into electrical impulses that then travel to the visual cortex and extrastriate regions of the brain. Colour doesn't exist until this information is processed by the brain - the retina only encounters energy in the form of light.



Human cone cells respond to light wavelengths of around 390-700 nanometres – this is the visible spectrum. When white light is passed through a prism, the light disperses depending on wavelength to create a rainbow of colour. There are three types of cone cells (S, M and L) which respond more strongly to different ranges of visible light. For example, when dispersed light from the prism hits the retina, L cones respond more to the section of the rainbow that has wavelengths of light 620-700nm.

The brain processes the information it receives from each cone type, and the colour we see depends on how much each cone type was stimulated. This is why we see red in the section of the rainbow with wavelengths of 620-700nm, but also why we can see colours like pink, that aren't in the rainbow. It is also why when day turns to night, colour disappears. Cone receptors aren't sensitive enough to respond to very dim light, and so the visual system uses rod cells instead. However, rod cells aren't sensitive to different wavelengths, and so we don't see colour at night, even though our eyes receive essentially the same wavelengths in day and night.

> "IT SEEMS VERY LIKELY THAT WE ALL SEE COLOURS A LITTLE DIFFERENTLY"

If the colour we see depends on how much each cone type is stimulated by light, then it seems very likely that we all see colours a little differently. It is fairly obvious in traits such as eye colour that there is variation between individuals, and this variation is the result of differences in the genes which code for the proteins that contribute towards that trait through properties such as their structure and function. How sensitive each cone type is to a wavelength of light, and which wavelength stimulates it the most, depends on photopsin proteins. Variation between individuals mean different people may have photopsins that respond slightly differently to wavelengths.

Of course, even if two individuals do see colours a little differently, this would arguably have no meaningful effect on their lives. For instance, teaching someone that an apple is called a banana would not affect their experience of it. If this is true, why do scientists even bother investigating it? There's a lot to be said for hunting knowledge for the sake of it – the Higgs boson, penicillin and DNA fingerprinting would not have been discovered otherwise. But, it is good to know that even if two people see the world a little differently, neither is wrong.

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