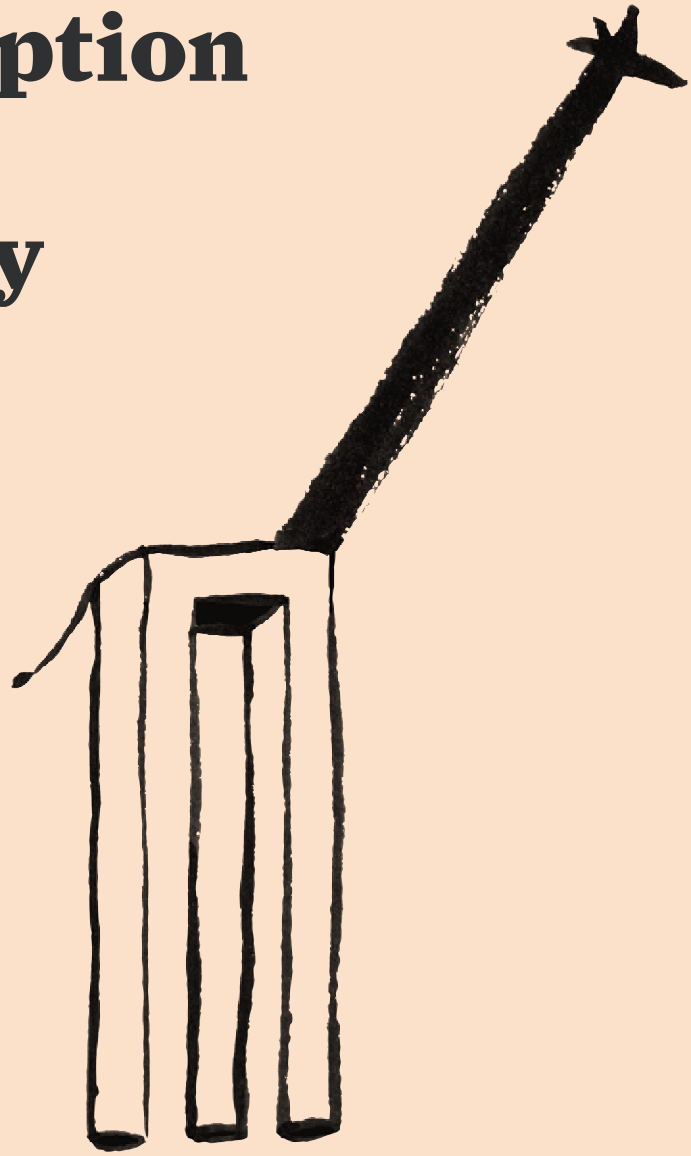
Perception and reality



Taken at face value, the picture of reality suggested by modern science seems radically opposed to the world as we perceive it through our senses. Indeed, it is not uncommon to hear scientists and others claim that much of our perceptual experience is a kind of pervasive illusion rather than a faithful presentation of various aspects of reality. Following this view, familiar properties such as colour and solidity – to take just two examples – do not belong to external objects, but are fictions generated by the brain that we mistakenly ascribe to the world around us. The world itself (so the story goes) is colourless, flavourless, odourless, and overwhelmingly empty save for the quantum perturbations of matter/energy that are studied by physicists. But is this a case where science and common sense are genuinely at odds, or can philosophy help us resolve the impasse?

by Keith Wilson

ARE COLOURS REAL?

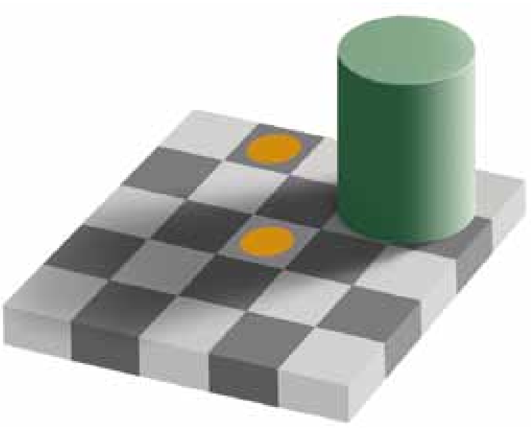
The temptation to think of perceptual experience as a kind of illusion arises in part from our susceptibility to illusions in general. Impressed by the possibility of such errors, many scientists take much of what we see, hear, touch, taste and smell – what philosophers collectively call perceptual experience – to exist only within our own minds. Take the chequerboard figure depicted below. The two spots appear to be different shades of orange, one brighter than the other. But examine the figure more carefully and you'll find that both are exactly the same colour. (I am using the term *colour* here to include different shades of colour, as well as black, white and grey.) Even more surprisingly, the squares that they lie on are also precisely the same shade of grey (if you doubt this, cover the rest of the figure with your hand or a piece of paper and compare them). Given that our senses can be so easily fooled, it is but a short step to concluding that all colour experience must be illusory, or that colours don't exist in external objects, but only in the minds of perceivers. But such a conclusion would be too hasty.

Just because the perceptual system can be fooled in certain cases doesn't mean that it's inaccurate in all cases. To see why, it's helpful to consider why this illusion works at all. The printed chequerboard diagram mimics the appearance of a real three-dimensional chequerboard in which a shadow is cast by a cylindrical object. Our visual system compensates for this apparent darkening in a way that enables us to correctly judge that the spots and squares are of different colours in the three-dimensional case, as they would need to be to create this appearance.

The illusion works not because colour experiences are illusory, but because our visual system has evolved to take into account lighting and other effects in order to reveal the underlying properties of physical objects under a wide range of possible circumstances. So far, there is no reason to suppose that these properties shouldn't include the colours of objects as well as their shapes, sizes, locations, and so on.

But why think of colours as properties of objects rather than simply a matter of which wavelengths of light are reflected towards our eyes? To understand the difference, we need to consider the phenomenon of colour constancy.

Different wavelengths of light certainly produce different colour experiences in us as well as in other creatures (more on that below). However, it would be a mistake to simply identify colours with light wavelengths. As with the chequerboard image, our eyes – or rather, our brains based upon information from our eyes – adjust for the overall lighting of a scene. On a summer's evening, for example, the light reflected into our eyes comes predominantly from the red end of the spectrum, whilst full daylight contains more blue. Yet provided that there is sufficient light to make out any colours at all, objects – say, a white piece of paper – do not appear to change colour from red to blue depending on the time of day. Instead, our visual system adjusts for the prevailing lighting conditions to reveal, or at least approximate, the actual colour of the object. That is to say, we experience the



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piece of paper as having a consistent colour despite differences in the precise mixture of wavelengths that reach our eyes at different times of the day. This is similar to what happens when you adjust a camera's white balance setting to compensate for sunny, cloudy or artificial lighting conditions, except that our brains do this automatically and continually in order to reveal the true colours of the objects around us.

Again, one might be tempted to say that all these corrections and adjustments merely show colours to be illusory rather than real, but the fact that vision is able to reveal the existence of stable and consistent properties that underly these variations suggests that there is more to colour than meets the eye.

One explanation for this is that colours are light-reflectance profiles. That is, they correspond to dispositions of objects to reflect certain wavelengths of light when placed under suitable illumination. Thus, a ripe tomato has the disposition to reflect mainly red light waves, whereas a ripe banana reflects mainly yellow light (or some combination of red and green) to produce its characteristic yellow appearance. Of course, everyone agrees that this is why ripe tomatoes look red whilst bananas look yellow, but crucially, reflectance profiles are properties of external physical objects and not of our minds. This would suggest that, far from being illusory, colours are perfectly objective, physical properties of the objects we see around us, just as we commonsensically take them to be.

But now we encounter a further problem. Our eyes are only sensitive to a small fraction of the electromagnetic spectrum, of which visible light forms just a part. Objects also reflect and absorb light from the infrared and ultraviolet ends of this spectrum, all the way up to radio waves and gamma rays. Even worse, all of the colours that we are capable of seeing can be created by combining varying proportions of red, green and blue light, these being the primary colours to which trichromat human eyes are sensitive.[1] This means that some reflectance profiles that yield different combinations of light waves nevertheless appear wholly indistinguishable to us.

White light, for example, can be produced by mixing just red, green and blue light, as occurs on your TV or computer screen. Alternatively, it can be produced by combining all the colours of the rainbow, as present in natural sunlight and revealed by shining the light through a glass prism. To a creature that is sensitive to more than just three primary colours, each of these forms, or metamers, of white would look quite different despite appearing identical to us. Such a creature is not just a theoretical possibility. Many species, including the humble goldfish, are tetrachromats, sensitive to four primary colours, and so capable of discriminating many more colour variations than we do, with some species of shrimp having as many as 19 distinct colour receptors.[2]

The problem, then, is not that reality contains no colours, but rather that it contains too many, both within and beyond the range of electromagnetic radiation to which our eyes are sensitive. Many of these exotic *colours* look identical or are completely invisible to us, making our perceptual abilities limited at best. Does this mean that the colours we are capable of seeing are somehow unreal? Not necessarily. To understand why, let us consider a different example: the notion of solidity.

IS SOLIDITY AN ILLUSION?

It is a scientific commonplace that solid objects are not really solid, but consist mainly of empty space. That is to say, the volume of matter (or vibrating loops of energy, depending upon which theory you prefer) in any given object is vastly exceeded by the amount of space between each particle at a subatomic level. This is certainly a surprising scientific discovery, but does it mean, as some scientists suggest, that solidity is an illusion? Well, if by *solid* you mean densely packed without any intervening spaces or gaps, then yes it is. But whilst this meaning of *solid* is perfectly acceptable when it comes to what the philosopher J. L. Austin called "familiar medium-

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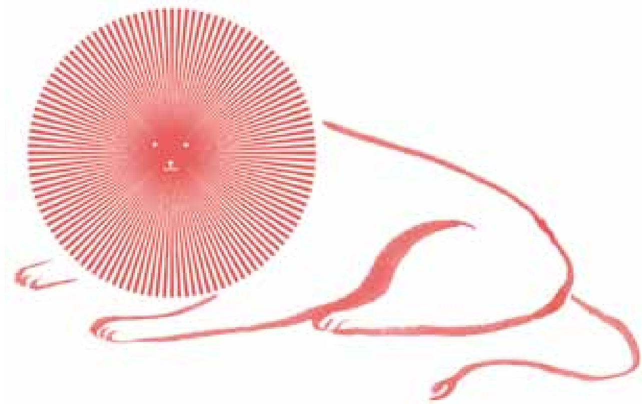

sized dry goods", science tells us that most objects are not like this at the atomic scale. Consequently, when we talk about the solidity of familiar objects, such as a piece of wood, we must mean something quite different. In this context, *solidity* picks out the property of being resistant to the touch, relatively stable, impermeable, and so on. The surprising scientific discovery, then, is not that no objects are solid, but that solidity at the macroscopic scale (i.e. ordinary solidity) does not coincide with the property of being densely packed at subatomic scales. Instead, macroscopic solidity is the result of electromagnetic forces acting between particles at the surfaces of objects, including our bodies, to repel one another. Indeed, without the existence of such forces, most physical objects would simply pass through one another.

We have now identified two different properties, each of which can be thought of as a kind of *solidity*. Consequently, it makes sense to say both that everyday objects are solid (at the macroscopic level) and that they consist of mostly empty space (at the microscopic level) without fear of contradiction. The two claims relate to quite different properties, both of which objects possess at the relevant scale. The temptation to say that solidity is an illusion arises from our tendency to conflate these two properties, bringing the scientific and commonsense views into apparent conflict. In practice, however, provided that we are careful about our use of language and understand each term in its proper context, these two views are perfectly compatible. Solidity, as it is ordinarily understood, refers to a real physical property of objects – namely, their ability to repel one another on contact – and so is not illusory after all. What, if anything, has changed is the meaning of the word *solidity*.

How, then, does this apply in the case of colour? I suggested above that there are many more *colours* in the world than humans are capable of perceiving. But what is meant here by *colour*? If it is the familiar shades of red, blue, yellow, and so on, then such exotica do not qualify as colours in the ordinary sense. We use the term *colour* to pick out what are colours for us. The existence of light reflectance profiles or metamers that yield colour-like experiences in other kinds of creatures need not require us to suppose that our own colour experiences are somehow illusory any more than the space between atomic particles means that physical objects lack solidity.

Rather, human perceptual experience grants us only partial access to the full range of properties that such objects possess. That some of these properties, like colours, turn out to be relatively complex does not make them any less real. Instead, the scientific and commonsense world views each capture different aspects of reality at different levels of abstraction or description. Far from our perceptual experience being illusory, then, as scientists sometimes claim, it is the idea that these two levels of description are necessarily incompatible or mutually exclusive that is the true, more subtle illusion.

1 Note that the primary colours for light are different to those for paint.

2 There is evidence that some women may be tetrachromats, though there is as yet no proof that this enables them to perceive additional colours.