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Key words
weight
illusion
perception
evidence

The dolls of confusion

How our senses can mislead us

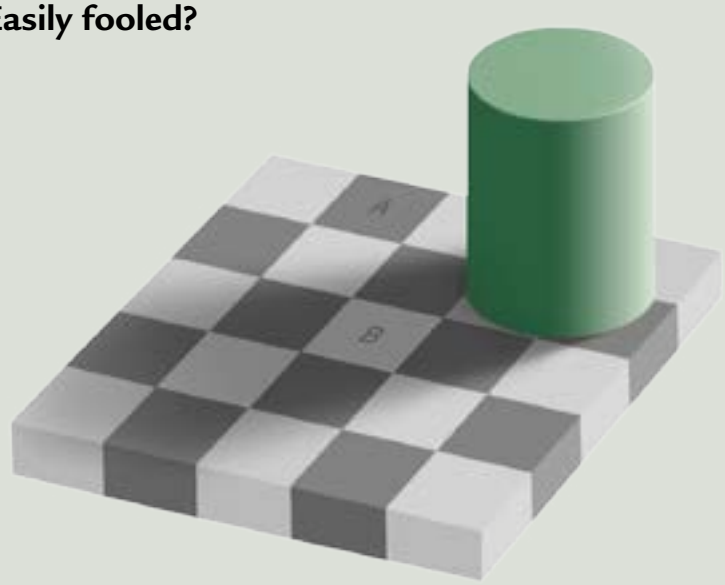
"I don't believe my eyes!" Have you ever heard anyone exclaim this?

Did you know that witness statements aren't sufficient for criminal prosecution? It's not necessarily that the honesty of the witness is in question, rather that it is quite possible that people can see things they didn't, or not see things they did. Human senses, it seems, just can't be trusted. The mismatch between reality and what we perceive is the basis of many a conjuring trick which can con an audience because they take the 'most obvious explanation' of what they see as being the most likely.

If you entered a 'guess the weight' competition you would have a better chance of a more accurate estimate if you closed your eyes and concentrated on what the object felt like.

Guess the weight of the cake, a traditional contest at fairs and fetes.

Easily fooled?



The grey square optical illusion

Our senses are easily fooled in many ways. Nearly everyone sees the two areas marked A and B as being different shades of grey, but they're not. To convince yourself they are the same grey, make a mask with holes that only show the two areas. The ink density in A and B is identical, and a camera or colour-measuring device will report identical values for both areas.

There are three effects happening to make this optical illusion work:

Firstly, the square appearing lighter appears to be in shadow. The human visual system can accommodate a gigantic range of lightness values, and part of the process enabling this makes things in shadows appear lighter than they 'really' are. Without shadow the effect wouldn't be so strong.

Secondly, the light one is surrounded by dark areas (and vice-versa). We don't see things in isolation but are programmed (psychologically and physically) to be more sensitive to differences – we actually perceive an enhancement of the differences as a cue.

Artists like Van Gogh were acutely aware of this effect and used the so-called 'simultaneous contrast effect' to enhance colours – so yellow stars painted in blue skies looked yellower (and the skies bluer).

Starry Night by Vincent van Gogh

Finally (and this is probably the most unsettling effect), you are pre-programmed with ideas about what things are, and this pre-programming can completely distort your perception. You recognize the pattern as being a chequer boards with alternate squares of light and dark. You know that A is light and B is dark, and although the amount of light present in both cases is the same you have been conditioned into seeing otherwise. This leads to an enhancement of differences.

Not convinced? You can see a deconstruction of the illusion here:

en.wikipedia.org/wiki/File:Optical_illusion_greysquares.gif

Look at these three cars and say if you see them as the same size. Measure them and find out the truth. Even when we know the truth it is difficult to over-ride what we think we see.

Over 100 years ago it was discovered by Augustin Charpentier that a smaller object 'feels' heavier than a larger one of equal weight; this is called the size-weight illusion. It is argued that this is caused by a mismatch between the sensori-motor prediction and the actual weight, causing motor commands scaled inappropriately for the object's weight. In other words, you expect a small object to be lighter than a large one so you try to lift it with a smaller force – and fail. However it was later shown that, after repeated lifting of the same object, the sensori-motor prediction adjusts so that the lifting force when grasping the object is correct, but the size-weight illusion still persists.

This leads us to conclude that the illusion is a purely perceptual one and comes from our knowledge of how the weight of a group of objects relates to their size. Our expectations from this then help us to adjust our grasp according to what we predict the weight is going to be, gauged by its perceived size. So size does indeed matter! (see Box: Easily fooled?)

Perception/misperception

From birth, the human brain develops sophisticated shortcuts and assumptions to speed up decision-making based on the information gathered by the senses. These shortcuts don't always work in a person's favour, and can actually misrepresent reality. This is a golden opportunity for tricksters and conjurers to deceive, and for us to be surprised when things don't appear as they are.

A typical set of Russian dolls

The NPL Russian dolls. These dolls were created by the National Physical Laboratory (the UK's national measurement institute) for the Royal Society Summer Exhibition in 2008 to show how complicated measurement can be and how deceptive the senses can be.

Everyone has seen optical deceptions but the world of illusions isn't limited to the visual. You might think that we were pretty good at judging weights, but for several years the National Physical Laboratory (NPL) has been bemusing audiences with the weight illusion in the form of 'The Dolls of Confusion'. The dolls were developed as part of a project called 'The Measurement of Appearance' to explain to the general public how odd perception can be. When given two Russian dolls of different sizes but the same weight people regularly said that the smaller doll was the heavier. The illusion persisted even when it was shown, using scales, that they were the same weight.

Children at a science exhibition try to put the dolls in order, from lightest to heaviest.

Asked to put a set of 6 dolls in order of weight seems an easy enough task, but no one has ever put our dolls in the order a set of kitchen scales would. Most people put them in the same order, which shows there is some normal 'human' way of doing this task. However, the results are completely wrong. The heaviest (largest) doll weighing in at 422 g is usually judged as being the lightest one, whilst the lightest, smallest doll weighing 133 g is usually judged as being the second heaviest. How on earth can people be so wrong? It is a good job this sort of task isn't a life/death decider.

World Measurement Day is 20 May each year and NPL has an open day then in 2014.

What we have learned

The main messages from this demonstration are:

People are not great at measuring things, in this case because they come with a pre-programmed 'expectation' against which the assessment is made. This is the reason why eyewitness statements just aren't good enough in a court of law, and expectation is the basis of many conjuring tricks.

Science is 'hard' because it is often non-intuitive; models have to be learnt from scratch.

Science is 'fun' because incongruity is the root of most humour, and you are just amazed that you are so wrong with the test.

Look here!

The MONAT project which spawned the dolls is summarised on the NPL website: *bit.ly/1lzXnlD*

There is film of the RS show stand here: *youtu.be/peEdMLSztBw*

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