

Dr Gary J. Doherty, 2nd of March, 2020, Robinson College Chapel

Blind faith

One of my favourite colours is magenta, but it doesn't really exist – my brain makes it up.

I see things move when I know that they are still.

I can see faces when I know that there are none.

I can tell you what colours things are, but don't believe me.

Some of my patients can't see anything from one side of their visual world, but they think that they can see what I see.

I know our brains are lying to us, yet I still trust mine implicitly.

Blind faith, perhaps.

Our brains make incredible connections to make the most sense of the world, and to allow us to focus on the most important things, extracting *signal* from *noise*. They pick out certain features of the world that they deem relevant to us, filling in the blanks and ignoring the rest.

Our eyes are not like video cameras – they are much more sophisticated.

A simple way to appreciate our remarkable eyes and brains is to think about how the left side of your visual world is being seen. The light is reflecting off the inside of the Chapel, or streaming through Piper's window, and entering your eyes. Light from your left is falling onto the right side of your right eye, and the right side of your left eye. Your eyes are moving around as your body moves, as your heart beats, as you try to focus on something. And yet your brain is telling you that you see the world clearly, and you aren't getting motion sickness or double vision. If the door over there suddenly opens, your eyes will suddenly focus over there and your brain will start ignoring me, and the process will be incredibly smooth and rapid.

Even before the signals get out of your retina, the inputs from your visual world have been transformed. The light has been detected by a family of cells called photoreceptor cells, which turn particular wavelengths of light into electrical signals using an amazing protein called rhodopsin. The vast majority of these are so-called "rods" – these are very sensitive and you rely on them at night when there isn't much light – they can detect even a single photon of light, the smallest amount possible! There are also cones, which are responsible for your colour vision – you have most of these in the fovea, which is where the light falls from the small area you are focussing on right now in the centre of your vision. Around half of the nerves that exit the eye to go to the brain are from the fovea. The retina also contains lots of other cells that help you start processing the world, finding edges of objects and the like – the eye has completely transformed the world, and that's before the brain has even had a go! The

eye sends signals out through the optic nerve to the brain, creating a blind spot in both eyes – there are no photoreceptor cells in this area, yet our brain fills this region in.

So our perception of the world through vision is a complete illusion.

Optical illusions can demonstrate how much we take for granted and question our versions of visual truth – they exploit our visual system’s tricks for decoding the environment, which have been fine-tuned on our evolutionary journey, and bring them to the fore. The Czech anatomist Jan Evangelista Purkinje, a towering figure in Neuroscience who died in 1869, put it best: “Illusions of the senses tell us the truth about perception.”

Let’s consider some examples on the sheet provided.

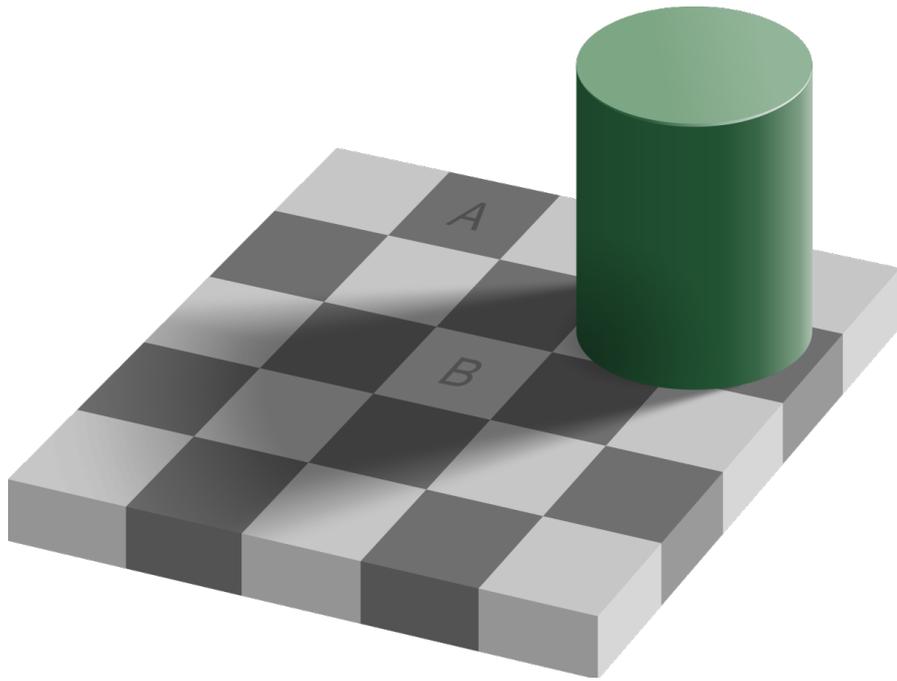
The Adelson illusion shows us how our visual system tries to compensate for differences in illumination. Even when we know that tiles A and B are the same shade, we still see them as distinct. Our brains know that brightness should be a product of reflectance and incident illumination. So our brains are trying to help us!

And there are illusions we can’t fully explain yet. The spinning wheels illusion tells us that we can perceive motion where there is none, presumably owing to the imperceptible small movements that our eyes are constantly making, and the brain trying to smoothen these out. And there’s the café wall illusion where we see clearly *straight* lines as *bent*. There are thousands of illusions, each exploiting our brain’s prowess at making our world interpretable and navigable.

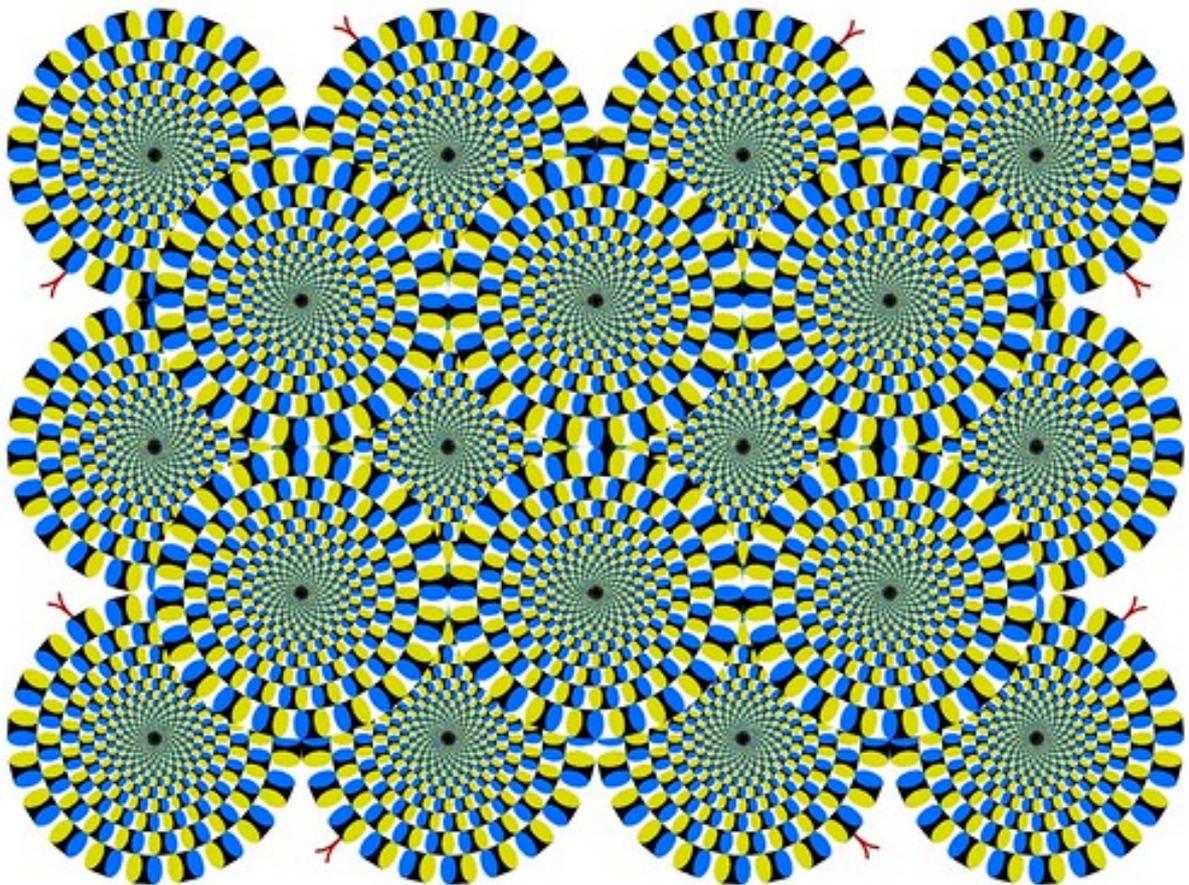
Many artists have cottoned on to this, either consciously or subconsciously. M.C. Escher et al. do this overtly, and lead the viewer into total disbelief, helping us question perception itself and the meaning of truth. Others do this more discreetly, including the Impressionists. Their deliberate use of complementary colours, for example, which are particularly pleasing to the brain and related to the afterimages we see when we stare at a bright colour and then look away, hold a crucial place in art history. Starting with Monet's Impression Sunrise, through Cezanne and colleagues and perhaps culminating with Vincent Van Gogh's works, we see their continued use of complementary colours and simultaneous contrast – such artistic tools are likely why these galleries are thronged with visitors. Neuroesthetics tries to apply our knowledge of neuroscience to understand aesthetic experience. Neuroesthetic theories provide explanations for why we like art works that we know to be poor representations of visual truth, such as where features that we are adept at recognising are exaggerated compared with reality; or where the use of contrast focusses our attention. As products of an enlightened age, we strive for meaning in art works, when perhaps the reasons we find many of them intriguing or beautiful are surprisingly simple, and shared with our evolutionary ancestors and pets. Perhaps we can take solace in the fact that only some of what we perceive and feel can be explained.

So what then is truth? Can we ever see the truth? What other things are our brains lying to us about? Just as our brain makes connections in vision to make sense of the world, the same will be true for all of our senses, and this should make us question our memories, the expertly processed and longer term by products of perception. The brain is a comfort blanket, perhaps shielding us from objective truth. Yet truth is much

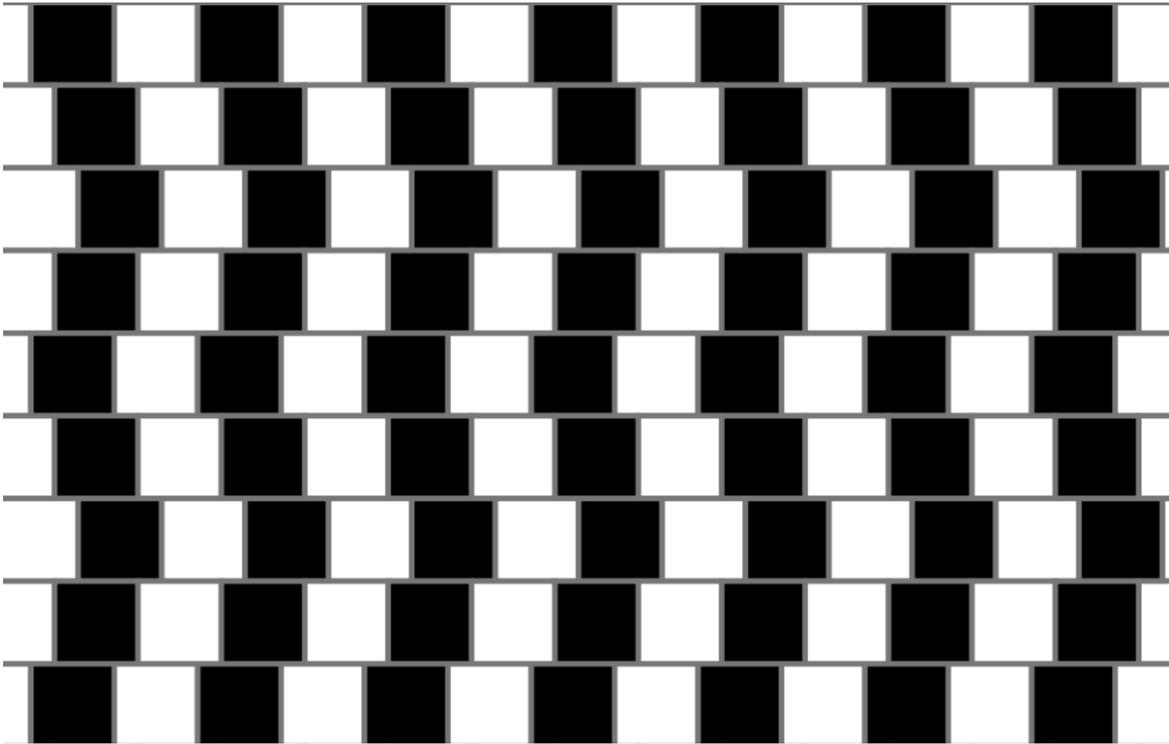
more than simply a record of events, such as a video camera of our lives might produce. It is something much harder to define: perhaps less of *what you see* and more of *what is there*. For each of us our brain uniquely uses the sum of our evolutionary and personal journeys to help us find meaning, search for truth and thrive. It is extraordinary and beautiful, and likely has a much clearer knowledge of truth than we will ever have.



Adelson Illusion



Spinning wheels illusion



Café wall illusion



Café Terrace on the Place du Forum, Arles, 1888. Vincent Van Gogh.