

Inside the mind's eye

Some people have inner thoughts as vivid as cinema, and they could help us unravel the riddle of consciousness, says **Daniel Cossins**

WHEN you are absorbed in a novel, what does your mind's eye see? For many of us, it is a foggy, low-contrast approximation of the scenes described, no matter how evocatively they are written. Not so for Clare Dudeney. "When people describe things, especially gory things, I visualise them so vividly it's like I'm experiencing them first-hand," she says. "A few years ago, I was on the train reading a passage about someone who got a nail stuck in their foot and I passed out." Dudeney is one of an unknown number of people with this ability, known as hyperphantasia. She only realised it a few years ago. Mental imagery is inherently private, after all. It is hard to articulate what you see in your own mind's eye, never mind get a sense of how it compares with everyone else's. But we now know it differs wildly between individuals. Some people find it impossible to picture their own bedroom, while others, like Dudeney, can call to mind images as sharp as they appear at the cinema.

These extremes of imagination are intriguing. A better grasp of what is going on in the brains of people who experience them could help tease out the role of mental imagery in emotion and mental health – and may be promising territory in the search for treatments for various psychological disorders. People with extraordinary imaginations might even reveal something about how we all experience the world.

"Sometimes I think we know more about outer space than we do our own minds," says

Emily Holmes, a clinical neuroscientist at Uppsala University in Sweden. "And mental imagery is a frontier ripe for exploration."

To summon an image in your mind's eye is to evoke the appearance of something that isn't there. That is an amazing ability, when you think about it. If our consciousness of the world around us is one of the most astonishing phenomena under scientific investigation, then our ability to imagine the world in the absence of any external stimuli is equally, if not more, impressive.

Arguably, our powers of imagination explain above all else why our species has come to dominate the planet. And although there is more to imagination than imagery, it is a significant component of our internal experiences, giving us a nifty way to recall the past and simulate the future.

In light of that, it might seem strange that, for a long time, we barely investigated our visual imagination. That was largely because we lacked the tools to do so objectively. But things began to change in the 1960s with the advent of brain imaging technologies. Eventually, these showed patterns of activity associated with visual perception in people who said they were imagining something. Various studies have since shown that calling to mind a mental image is in neurological terms a fuzzy form of visual perception. In other words, it can be measured and investigated.

One of the first to do so was Joel Pearson, a cognitive neuroscientist at the University of New South Wales in Sydney. In 2008, he and

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his colleagues developed a way to test the strength of people's mental images. The technique takes advantage of a phenomenon called binocular rivalry in which people perceive one image despite their left and right eyes being shown different images at the same time. Which one they see can be influenced by a simple trick: if you flash up a picture of a house, say, before showing someone two images, one of a house and one of a car, they are far more likely to perceive the house.

This effect exists because people create a picture in their mind, based on the image that was flashed up first, says Pearson, which

primes them to perceive it again when faced with two images at once. "What you imagine literally changes the way you see the world," he says.

Pearson thought this priming effect would be stronger in people who have a more vivid mind's eye, giving him an objective way to corroborate what people report about the vividness of their mental imagery. Sure enough, in 2011 he discovered that people who report having no mental imagery whatsoever, a condition known as aphantasia, didn't respond to image priming any more than you would expect by chance. At the other

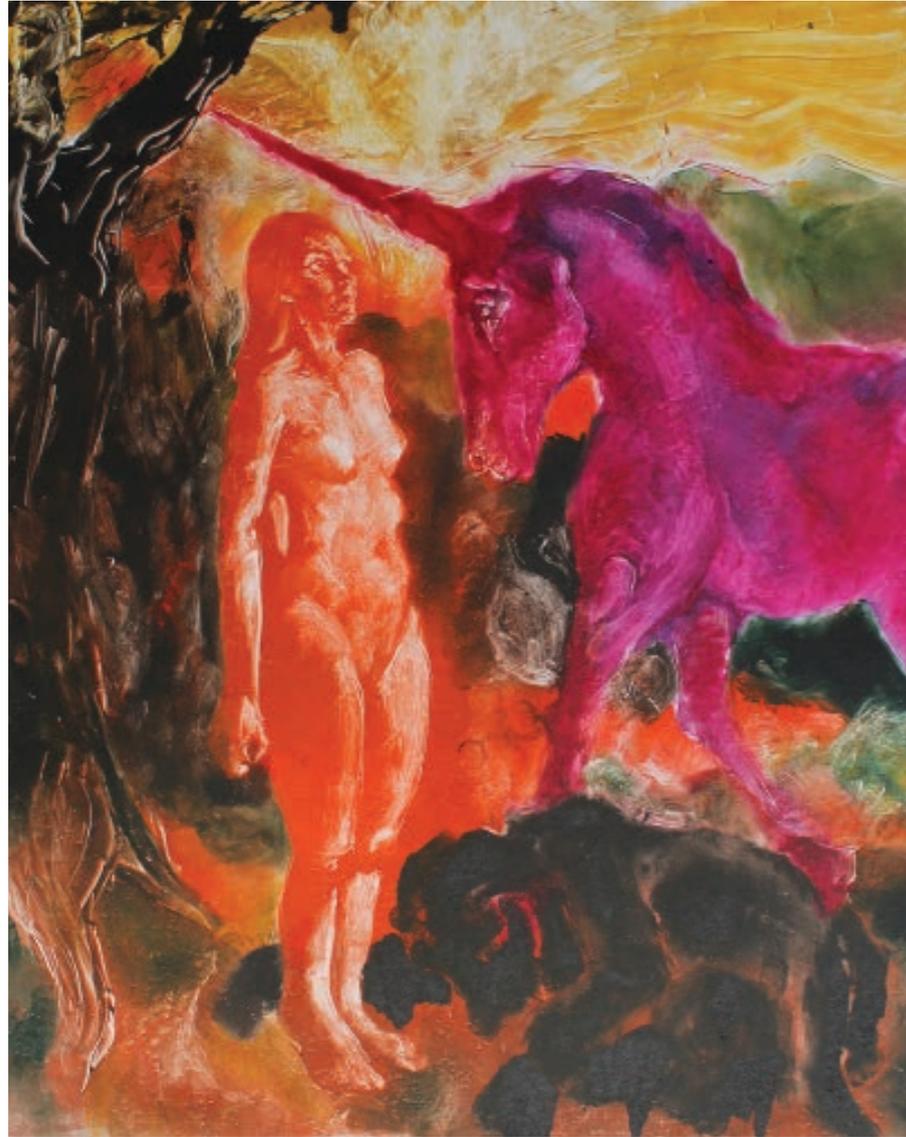
end of the spectrum, people who say they experience extremely vivid imagery were far more susceptible to priming than those who report being somewhere in the middle.

So why is there a difference between what we all see in our mind's eyes? In 2010, Adam Zeman, a neurologist at the University of Exeter, UK, published the details of the case of a man known as MX, who reported losing his mind's eye after heart surgery. Since then, Zeman has heard from several thousand people who say they have always been aphantasic and a few hundred who are hyperphantasic.

Pearson has also been asking for volunteers to take part in neuroimaging studies. What research from Zeman and Pearson has revealed so far offers some hints about what lies behind the differences.

The first came in 2016, when Pearson and his colleagues performed brain scans on 36 people and showed that those with stronger imagery than average had a smaller visual cortex – the region that processes information from the eyes – than the others. A similar study Pearson conducted found that people with stronger mental imagery also had lower neural activity in the visual cortex but





higher activity in the prefrontal cortex, which is known as the brain's command centre because it exerts control over other areas. "In terms of what determines the strength of your visual imagery, it seems to be partly about neural architecture and partly about activity," says Pearson.

He compares the visual cortex to a canvas, the place where you generate images. The idea is that if there is a lot of activity in the visual cortex, or if the canvas is already covered with paint, it is hard to see the picture. "The noise seems to disrupt the visual image," he says.

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For their part, Zeman and his colleagues have studied brain activity while people looked at, and later imagined, famous faces and buildings. They found that people who rated their mental imagery more highly on a survey called the Vividness of Visual Imagery Questionnaire (VVIQ) activated a smaller set of brain regions as they called to mind images than those who scored low on the test, and vice versa. "That fits with a lot of other studies showing that when you get good at something, you tend to use less brain, as if you've become more economical," says Zeman.

Image-fuelled emotions

Most of these studies have been conducted on people with middling mind's eyes. When it comes to the extremes of mental imagery, especially hyperphantasia, we know very little. But Zeman has noticed a few intriguing associations emerging from studies he has carried out. For instance, people with very vivid imagery tend to say that they have good autobiographical memory and no difficulty remembering faces. And there seems to be an association with synaesthesia, a neurological trait in which senses overlap so that it is as if you can hear in colours or see in sound.

"There is some intriguing impressionistic stuff as well," says Zeman. "People with hyperphantasia say they spend more time daydreaming than most, presumably because they have such vivid material. They also seem to be more prone to emotions fuelled by imagery, such as regret, longing and nostalgia."

One of the few hyperphantasics who has made herself available for studies is Dudeney, an artist from London. She met Zeman in 2017 at an exhibition for which she had created a series of paintings of visions she saw in her dreams (see images, left and right). When she described the vividness of her visual imagination, Zeman invited her to take the VVIQ and have her brain scanned. She wasn't shocked to find she had hyperphantasia, but she was surprised that everyone else didn't. She had assumed everyone's mental imagery was as vivid as her own.

"I realise now that when I was a child, I learned to read by making mental images," says Dudeney. "When my teacher stopped me from closing my eyes and visualising the letter and words, I was completely stuck." These days, she thinks it is important in her art and she sees her extraordinary imagination as a boon, not a burden. She does, however, have the odd occasion when she has to ask people to stop describing something gruesome.

There are reasons to suspect that not all people with vivid imagery see it as a plus, however. Over the past decade, researchers like Holmes have found that mental imagery has a powerful influence on our emotions and mental health. Time and again, Holmes and her colleagues have shown that when healthy volunteers are asked to imagine negative scenarios, they report much more intense feelings of anxiety than those asked to think about the meaning of words in descriptions of the same scenarios.

That makes intuitive sense. If imagining an image is a weak form of seeing the real thing, it is bound to have knock-on effects. When you imagine your favourite meal, for example, you salivate involuntarily. When someone with a fear of social situations imagines themselves blushing or sweating at a party, they feel anxious. Indeed, Colette Hirsch at King's College London has shown that rather than simply being a side effect of social phobia, negative mental imagery plays a role in causing those feelings. When Hirsch and her colleagues asked socially anxious volunteers to hold in mind negative images as they chatted to strangers, they reported feeling more anxious and believed they came across less well. "It's not how people really appear to others but how they see themselves in their mind's eye," says Holmes.

This knowledge could help treat conditions like post-traumatic stress disorder. One of its hallmarks is intrusive memories of traumatic events, flashbacks that typically come in the form of vivid images with a strong sense of immediate threat. There are evidence-based psychological treatments available, but understanding the role of mental imagery has helped Holmes to come up with another potential preventative approach. She and her colleagues have shown that it is possible to reduce intrusive memories by asking people to do something that involves imagery, such as playing the computer game *Tetris*, shortly after they have experienced a traumatic event. "You can't hold two mental images in your mind at once," says Holmes. "So if you do something that competes with the images from the traumatic event whilst these trauma memories are being laid down, you may be able to stop them intruding."

Most recently, Holmes has shown that a suite of imagery-intervention techniques can help people with bipolar disorder, whose mood fluctuations are often driven by recurring mental images of what might happen in the future. These include "imagery rescripting", in which people

Clare Dudeney, who has a vivid mind's eye, has painted pictures based on her dreams (far left), and memories of the natural world (right)



“Our conscious experience of seeing is a product of visual signals and memories”

are encouraged and guided to imagine alternative, more positive, images.

All of which has led Zeman and Pearson to wonder whether people with an extremely vivid mind's eye are more susceptible to certain psychological disorders. And on the flip side, could aphantasics be to any extent immune?

Neither has been able to test the idea and Holmes insists we should be careful not to make assumptions. "It is an interesting hypothesis but the fact is that we don't know, because nobody has done the research," she says. "It could be the opposite. It could be that people with hyperphantasia have better control over their imagery."

In any case, the implications of our nascent understanding of mental imagery aren't limited to mental health. According to Pearson, figuring out the neural process underlying our ability to conjure images in our mind's eye might tell us something about consciousness itself. "This is something I'm trying to convince my colleagues about," he says.

His argument runs like this. Broadly speaking, our approach to explaining the mystery of consciousness has centred on the visual side of things: what goes on in the brain to make us conscious of seeing an apple, say? The trouble is, our conscious experience of seeing an apple is a product of not only the visual information entering through our eyes but also our memories and expectations.

Our brains are constantly predicting what we will see, generating signals from non-visual parts of the brain that feed into the visual cortex, where they are combined with information from the eyes to produce an image. That explains why we are so readily tricked by visual illusions. It also makes it very difficult to unpick which elements of consciousness come from expectations and which come from external stimuli.

That particular problem could be eased by studying the mind's eye. Conjuring mental imagery is one of the few scenarios in which you have a conscious experience of the apple with your eyes closed, unpolluted by visual information.

"It's a pure form of internal conscious perception," says Pearson. "So by studying mental imagery, I believe we can figure out how the brain uses feedback signals to create consciousness. We can unlock the secrets of how we experience the world." ■



Daniel Cossins is a staff feature writer for *New Scientist*