11. VISION

EYE OPENERS

SCIENTISTS AND ART HISTORIANS HAVE BEEN LOOKING INTO THE WAY WE SEE FOR CENTURIES. THE NEW WAVE EXPLORES VISUAL PERCEPTION FROM FRESH PERSPECTIVES.

ART ON THE BRAIN
An eye-opening tour of the Louvre with Patrick Cavanagh

Patrick Cavanagh started out as an electrical engineer, and it was an interest in artificial intelligence that led him closer to his current preoccupation, human cognition. The brain is a large place, however, and he eventually settled on one part of it, the visual system, as the focus of his research. In the 1980s he was introduced to the work of artist George Kleneck, whose two-tone images appeared meaningless until you were given some extra information about them, and he became intrigued by the question of how the brain made sense of these images. So was born an interest in art, which led him deep into the world’s greatest museums, and into an intimate relationship with the Old Masters. The larger question that he now explores, of how the brain reconstructs the three-dimensional world, has led him to invent a new subdiscipline: art as neuroscience research.

It’s a baking hot day in July and the queue to enter the Louvre snakes away from the glass pyramid, while in the cool of the entrance hall below, Patrick Cavanagh flashes a card at an attendant and heads into the galleries with the sure step of a man who knows his way through the labyrinth. And so he should, because for this cognitive neuroscientist, the Louvre represents one vast laboratory. The paintings that hang here, along with those that hang in the Hermitage, the Uffizi and the Met, represent the culmination of a 40,000-year experiment that began when a Stone Age man or woman, perhaps sitting out a downpour, sketched an auroch on a cave wall. Cavanagh spends hours in these temples to the human visual cortex, trying to find out what scientists can learn from artists about how the brain sees. And today he’s invited me along to glean a few of those hard-earned lessons. Our tour begins, appropriately, in the gallery of French painting, in front of Henri Bellechose’s altarpiece, The Martyrdom
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of St Denis. At the centre of this work is Christ on the cross, and the figures that cluster around him seem both to crowd into the plane of the painting and to float ethereally off the ground. The reason they do so, Cavanagh explains, is because of the complete absence of shadows in the painting, and hence, of any sense of depth. The same is true of all the medieval paintings in this gallery, and I’m just wondering what is special about this one, when he points to Christ’s loincloth, which is transparent.

Painting shadows requires the same technical knowhow as painting transparency, he explains. In both cases, the artist must convey how something see-through flows over, and reveals the contours of the surface behind it. “If you can paint transparency, you can paint a shadow,” he says. So Bellechose could have painted shadows, but he chose not to. Why?

“Experimenting with ways to convince people, artists discovered that certain elements were essential and others dispensable,” says Cavanagh. Bellechose’s painting may lack realism, but the story it tells is crystal clear: we understand what happened to Denis despite the absence of shadows. In other words, medieval artists like Bellechose already understood that the human brain doesn’t need all the visual information the world has to offer in order to make sense of it, and shadows are one of the things it can do without.

This is lesson number one on our whistle-stop tour of the Louvre: art embodies an ‘alternative physics’, which is a pared-down version of real-world physics. And this alternative physics is the one that our brains extract from the world. The most obvious example of it is the line drawings that humans use to represent three-dimensional objects graphically, from the mammoth drawn on a cave wall at Lascaux 17,000 years ago, to the stickman that a schoolchild somewhere in France doodled in her notebook today.

The brain has no trouble understanding, for example, that a T-junction in a line drawing represents one surface occluding another. The T-junction is one element of a graphic code that is common to all human cultures and all stages of development, from the moment drawing emerges. “If two-dimensional images didn’t work for us, we’d all be carrying little statues of our loved ones around in our wallets,” says Cavanagh. The fact that humans are so comfortable with two-dimensional representations of a three-dimensional world suggests that the brain’s internal representation of that world may lie somewhere between the two. “It’s more than 2D but less than 3D,” he says, “just enough to allow us to manoeuvre efficiently through the world.”

The brain’s anatomy hasn’t changed much in the last 40,000 years, but art has, as each new generation of artists has found its own way to test the visual system’s limits. This is why Cavanagh sees art as such a rich, and still largely untapped, seam of information for neuroscientists.

Bellechose painted his altarpiece in 1415. Centuries before he picked up a paintbrush, the Romans had mastered the painting of shadows, as the frescoes preserved at Pompeii attest. The ancient Greeks were wizards at it too. In 200 BC, Athenian shadow painters competed with each other to fool the public with their breathtaking trompe l’oeil paintings. But by about 400 AD, shadows had vanished from mainstream European art.

The ensuing ‘shadowless period’ lasted 1,000 years, roughly the duration of the Middle Ages. One explanation for it is that, after the decline of the Roman Empire, the Church became the main sponsor of art in Europe, and it encouraged a shift away from Roman and Greek realism towards a more Byzantine style – “all stiff and flat”, as Cavanagh describes it. It’s a style that lived on for centuries in Russian icon painting. But in Western Europe, around 1425, the shadowless period came to an abrupt end.

In the gallery of Flemish painting, armed with my new knowledge of alternative physics, I gaze in wonder at Rogier van der Weyden’s Annunciation. Though he painted the triptych of which this formed the central panel only 20 years after Bellechose painted his altarpiece, his masterful use of shadow, reflection and perspective seems to have pinned the three-dimensional world down onto a flat canvas – not cartoonishly or ethereally, but with almost photographic realism. Gone are the crowded foreground and the strangely levitating figures: these Flemish burghers are thoroughly grounded. When Cavanagh describes the transition as “like aliens landing”, I know what he means.

What happened in that part of northern Europe that inspired van der Weyden and his contemporaries Robert Campin and Jan van Eyck, author of the celebrated Arnolfini Portrait, to
paint so naturalistically? Nobody knows, but there are plenty of theories. One of them, first put forward by British artist David Hockney and American physicist Charles Falco about 10 years ago, suggests, controversially, that the Flemish painters had begun using optical aids such as the camera lucida, which uses lenses to project the subject’s image onto the drawing surface—a practice that they think gradually spread across Europe.

But the artists’ props, or lack of them, don’t interest Cavanagh so much as the errors they made. He points out small abuses of the laws of physics in works of the Flemish school, such as a shadow falling the wrong way with respect to the light source that created it. These reveal tolerances in our visual system, he says, since they do not detract from our understanding of the image, or its naturalistic appearance. Another artistic error our visual system tolerates is impossible mirror images, where a reflection in a vertical mirror could not be what is painted, given the laws of optics and the observer’s viewpoint. An example is Rubens’ Toilet of Venus, in which Venus appears to be gazing at her own face, when she should be seeing us, or the painter.

Laboratory experiments have shown that people have only a very hazy understanding of what should be reflected in a mirror that is angled a certain way, or conversely, where they ought to stand in order to be able to see themselves in it. Painters over the centuries have exploited that haziness—which psychologists Marco Bertamini and Heiko Hecht have called ‘naïve optics’—to artistic effect, as Rubens did, depicting sometimes outrageously impossible reflections in the knowledge that observers will still understand they are looking at a mirror image.

On the other hand, says Cavanagh, very few serious painters...
have ever got a reflection in a horizontal surface wrong – the reflection of the moon in water, for example. The reason is that horizontal reflection represents an unbreakable rule, a mainstay of the visual system by which it understands the relative position and nature of things. If the reflection is off-beam or inexplicably distorted, the reflective surface no longer appears reflective, but textured or patterned. And this rule seems to have very ancient evolutionary origins. “Birds will attack their reflection in a mirror, but not in water, so there’s something across species that understands reflections in water,” says Cavanagh. Water, of course, has always been with us, whereas mirrors are a relatively recent invention. That might explain why our brains know what to expect from the former; less so from the latter.

Another cardinal rule concerns transparency. If an artist doesn’t capture features of the surface behind a piece of material, then the observer won’t see that material as transparent. That is one reason why medieval painters continued to get transparency right, long after they had done away with shadows. The fact that finely woven, transparent cloth also symbolised wealth – in particular, the wealth of the person who could afford to commission an artist skilled enough to paint it – may have been an added incentive.

And though shadows are dispensable when it comes to understanding depth, when they are depicted, they must obey this transparency rule. The Fauvists Maurice de Vlaminck and Georges Braque toyed with the colour of shadows, countless others have manipulated shadow size with impunity, but all artists recognise that a shadow must be darker than the surface it falls on, which must be visible through it. If a shadow is too light, or if you can’t see what’s behind it, then you will interpret it as a hole or a stain, or perhaps an object placed over another object.

It was the visual system’s use of shadow that first got Cavanagh interested in art as a research tool, back in the 1980s. Giorgio Kienerk, an Italian artist working at the turn of the 20th century, painted high-contrast, two-tone images, and looking at them Cavanagh began to wonder how people were able to distinguish between real physical boundaries, such as an eyebrow or a jaw, and shadow, since Kienerk represented both using the same dark pigment.

It turns out that they are only able to do so when the image is of a familiar object or person – in other words, when they have prior knowledge that they can bring to the task of interpretation. In that case, the brain compares its stored template of the object, the possible match, to the two-tone version, rapidly extracts the subset of contours that represents real boundaries and, ignoring the shadows, definitively identifies the object. How the brain solves this highly complex problem remains a mystery, however.
Kienerk knew that, without prior exposure, people saw his images as random shapes. He could therefore manipulate their perception by offering or withholding the information they needed to decode them. He set out to disconcert people with his art, as did the Athenian shadow artists and M.C. Escher, creator of the impossible staircase. Intuitively, these artists understood that the brain extracts a skeleton of information from the visual field and fleshes it out from memory. They then exploited that inherently risky strategy to suggest erroneous solutions.

Other artists’ errors may have been accidents, glitches in the application of the universal graphic code, and if their works still hang in our museums, it’s because our brains take no notice of those errors. Take Fra Carnevale’s The Birth of the Virgin, painted in 1467 (clue: look for shadows around the base of the columns). But between the accidental and the deliberate lies a third category of mistake: call it the deliberate accident. We happen to be walking past one of these now, in the shape of the Mona Lisa.

A few years ago, a group led by a colleague of Cavanagh’s at Harvard, Margaret Livingstone, decided to investigate the enigma of the lady’s smile. They found that Leonardo da Vinci had painted it in low spatial frequencies. That is, the corners of her mouth are only uplifted in a slightly blurred pattern, a shadowy continuation of the line of her cheeks. Just looking at the high spatial frequencies of the mouth area — that is, the fine detail — reveals her lips to be set rather demurely. Because we are better at detecting fine detail with our central vision, and blurred patterns with our peripheral vision, the smile therefore seems to become more or less accentuated depending on the direction of our gaze. Did Leonardo mean to give the smile that enigmatic, dynamic quality? Probably, which is why we admire him for it. Could he have explained how he did it? Almost certainly not. Perhaps the greatest artists in history have known exactly how to achieve the effects they desired, without being able to explain how they achieved them.

On that note, our tour comes to an end. With a nod to Giovanni Gerolamo Savoldo’s 1525 self-portrait and its spectacularly improbable mirror image, we head back into the entrance lobby and up into the sunshine. I think I understand now what Cavanagh means by the alternative physics of art, and it feels strange to have looked at these paintings and known scientists call it metacognition — how the artists were manipulating my brain even as they manipulated it. Stranger still is knowing that the artists in question have all been dead for hundreds of years. At any rate, one thing is certain: I’ll never look at the Louvre’s treasures with the same eyes again.