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## What you experience may not exist. Inside the strange truth of reality

What our senses allow us to experience may not reflect what actually exists. It may be a creation of our own consciousness, or a computer simulation designed by superintelligent beings

**PHYSICS** 29 January 2020

By [Donna Lu](#), [Alison George](#), [Daniel Cossins](#) and [Layal Liverpool](#)



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### Can we perceive reality?

[Alison George](#)

I don't know about you, but I feel that I have a perfectly good perception of reality. Inside my head is a vivid depiction of the world around me, replete with sounds, smells, colour and objects. So it is rather unsettling to discover this might all be a fabrication. Some researchers even contend that the live-stream movie in my head bears no resemblance whatsoever to reality.

In some senses, it is obvious that subjective experience isn't the whole story. Humans, unlike bees, don't normally see ultraviolet light; [we can't sense Earth's magnetic field](#), unlike [turtles](#), [worms and wolves](#); are deaf to high and low pitch noises that other animals can hear; and have a relatively weak sense of [smell](#).

### **"Everybody knows that we don't see all of reality. I say we see none of it"**

On top of this, our brain presents us with only a snapshot. If our senses took in every detail, we would be overwhelmed. Did you notice the last time you blinked, or that fleshy protuberance called your nose that is always in your peripheral vision? No, because your brain edits them out. "A lot of what our senses are doing is something like data compression: simplifying, in order to be able to function," says [Mazviita Chirimuuta](#) at the University of Pittsburgh in Pennsylvania.

In fact, most of what you "see" is an illusion. Our eyes aren't all-seeing, but capture fleeting glimpses of the outside world between rapid movements called saccades. During these, we are effectively blind because the brain doesn't process the information that comes in when they happen. If you doubt this, stare into your own eyes in a mirror, then rapidly flick your gaze from one side to the other and back again. Did you see your eyes move?

This is only the start of it. The brain, after all, is sealed in darkness and silence within the solid casing of the skull. It has no direct access to the outside world, and so relies on the information that reaches it via a few electrical cables from our sensory organs. Our eyes pick up information about wavelengths of electromagnetic radiation, our ears detect vibrations of air particles and our noses and mouths detect volatile molecules that we experience as smells and flavours. Through complex processes we only partly understand, the brain integrates these independent inputs into a [unified conscious awareness](#).

The question is, how well does this subjective internal picture represent objective reality?

It is a contentious query, much debated by philosophers and physicists. What do we even mean by objective reality? For Donald Hoffman, a psychologist at the University of California, Irvine, and author of *The Case Against Reality*, it is "something that exists even if no creature perceives it" (although, ironically, some physicists may beg to differ – see "Do we make reality?").

But it is impossible to know anything about objective reality without also involving perception and thought. This is why some people think that there is no hard line between objective and subjective reality. "If you have this notion that reality is something that is inherently different from the mind, then it becomes paradoxical to think that we ever have access to reality," says Chirimuuta. "Reality depends on us, it depends on the way we see the world. But at the same time, what we're perceiving is one aspect of this reality because our perception is shaped by the senses we happen to have."

### **Kind of blue**

Take the colour blue. Physicists define it in terms of wavelengths of light, but for Chirimuuta, we can't remove perception from the equation. Blueness, she argues, isn't a property of the object but a property of the interaction we have with it.

Other animals probably experience their own versions of reality. This logic also applies to the reality depicted by science. "The world described by physics is also like another interpretation based on measurements taken with scientific instruments that reveal properties and processes that the human senses can't, by themselves, latch on to," says Chirimuuta.

Others go further and argue that nothing we perceive bears any resemblance to reality – and that it wouldn't actually be helpful to "see" things as they really are. "I think that everybody recognises that we don't see all of reality. I'm saying we see [none of reality](#)," says Hoffman.

To get your head around this, imagine you are playing a virtual reality game. You might be driving a car, for instance, and can see the steering wheel in your hands. "We all know that these objects don't really exist, they are the result of computer software that renders them," says Hoffman. There is a reality to the game, but it is the software and circuits of the computer. It would be impossible to play the game if we operated at this level. Instead, our brain perceives constructs such as the steering wheel, letting us play.

Hoffman argues that this trickery doesn't just happen in video games, but in every moment of our lives. "What I'm claiming is that we're born with a virtual reality headset on. Evolution gave us a VR headset to simplify things, to give us what we need to play the game of life, without knowing what the reality is."

According to this view, our brain and sensory system together make a user interface that simplifies the complexity of the world – in the same way that the icons on a smartphone screen are tools to operate the gadget’s underlying circuitry. Everything we see is really an “abstract data structure for something that doesn’t even exist in space and time”, says Hoffman.

This is a dizzying view if you naively think that what you perceive really represents the true nature of the world. But in practical terms, it doesn’t matter. What matters is whether what we perceive allows us to successfully navigate this world – to survive long enough to pass on our genes. “Evolution has shaped us to see things that we have to take seriously, to see what we need to stay alive,” says Hoffman. “But that does not, logically, permit us to say that we’re seeing the truth.” How’s that for a dose of cold, hard reality?



## Is your perception of reality the same as mine?

**Loyal Liverpool**

OUR conscious experience of reality may be nothing like the real thing, but do people at least share the same misrepresentation? It is a reasonable assumption that we do – all humans have roughly the same brains and sensory systems, and when we talk about our conscious experiences we all seem to be on the same page. But we cannot be sure. The only way you know you exist as a conscious being is experience of your own consciousness. The nature – and even existence – of other people’s consciousness is a closed book. For all you know, everybody else is a zombie.

Let’s set philosophical solipsism to one side, however, and allow other people to have conscious experience. Do they all perceive the same events in the same way? The evidence suggests that they don’t.

If you have ever watched a football match and felt incredulity at the referee’s decisions, take comfort from the fact that the opposing fans feel the same – although for the opposite reasons. Both sets will end up feeling that they were on the wrong end of all the dodgy calls.

This, of course, isn’t objectively possible, but since when did objectivity have anything to do with reality? “We perceive the world in relation to what we already believe,” says Tali Sharot of University College London. This makes evolutionary sense because it allows us to create mental shortcuts. Evaluating every piece of information anew would use up scarce mental resources, says Sharot. But the shortcuts open us up to many of the vices of the modern world, from fake news to conspiracy theories.

## Truth and lies

These are nothing new, yet the proliferation of digital media has shattered any notion of a shared baseline “reality” that everyone can agree on. Instead, people can seal themselves into partisan [filter bubbles](#) or echo chambers in which they encounter only information that conforms to their world views.

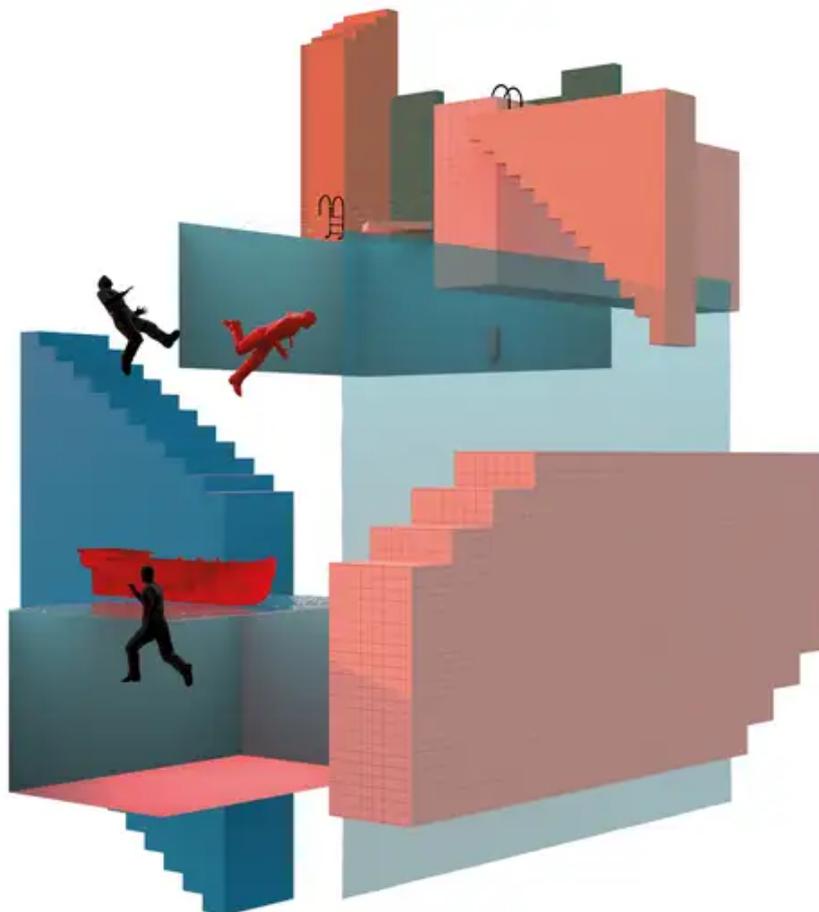
How is it that people can live in the same reality and yet experience it so differently? One obvious answer is that we are being lied to. Another is that we seek out or interpret facts to fit our pre-existing beliefs because of traits known as motivated reasoning and confirmation bias. Both are undoubtedly in play, but research on how our brains deal with information has revealed that something weirder is going on. It isn't merely a problem of interpretation, but of sensory perception itself. We literally see the world as we want it to be.

If you don't believe that, consider this [experiment by Yuan Chang Leong](#), now at the University of California, Berkeley.

He scanned people's brains while they viewed a series of images of faces merged with scenes. Participants had to decide whether an image contained more face or more scene and were paid for correct answers.

Leong also threw in an occasional curveball, offering to pay a bonus if the next image was more face, impose a penalty if it was more scene, or vice versa. Subjects reported seeing what they had been told would be more profitable. And it turned out that they weren't consciously fibbing for profit: activity patterns in the brain's visual cortex suggested that they were seeing what they said they were seeing.

This “motivated perception” isn't unique to vision. Other studies suggest smell, taste, reasoning and memory are influenced too. That seems strange, but again makes evolutionary sense. “The main goal of the perceptual system is to keep the brain alive, so you can pass on your genes,” says Jay van Bavel at New York University. You might assume that this would favour authentic perception, and mostly it does – but not always. We are a social species and sometimes group identity, tribal cohesion and shared beliefs are more important than the truth. Just ask a football fan.



## Do we make reality?

[Daniel Cossins](#)

At first blush, to suggest that we create reality sounds like a combination of arrogance and absurdity. In what warped version of reality could reality only exist because of us? And yet if you spend any time pondering quantum theory – our most accurate description of reality at its most fundamental – it is hard to escape the idea that the world becomes “real” only when we are looking at it.

The starting point for this is the peculiar fact that observation seems to play a key part in transforming the ambiguous quantum world into the definite picture we know as classical reality. An electron, for instance, is said to be in a superposition of many places at once because, like all quantum objects, it exists in a cloud of possibilities. These possibilities are encoded in a mathematical entity called the wave function, until it is measured. At that point, the wave function collapses and all the possibilities are reduced to one. The electron assumes a single, definite position or state – something we would recognise as real.

### **“We perceive the world in relation to what we already believe”**

That much is well-established, but the word “measured” is a weasel one. “Collapse happens on measurement, but ‘measurement’ is vague and anthropocentric and seemingly inappropriate to play a role in a fundamental description of reality,” says Kelvin McQueen, a philosopher of quantum physics at Chapman University in California.

Consider the double-slit experiment, in which a beam of light is shone through two side-by-side slits onto a screen – the classic demonstration of wave-particle duality. The experiment can be set up to force a wave function to collapse, as revealed by the pattern of light on the screen. But when does the measurement actually happen: when the light passes through the slit or when it hits the screen? Now imagine replacing the screen with a photographic plate that you don’t develop until later. Again, when does the measurement happen? This “measurement problem” is one of the biggest mysteries in physics.

Unless, of course, you take seriously the notion that wave function collapse is brought about not by measurement but by the intervention of a conscious observer. John Wheeler at Princeton University was among the most eloquent proponents of this viewpoint. “Nothing is more astonishing about quantum mechanics than its allowing one to consider seriously that the universe would be nothing without observership,” he wrote.

The idea raises some difficult questions, none of which is easy to resolve. For one thing, consciousness is arguably no less vague than measurement, even if [integrated information theory \(IIT\)](#), which offers a mathematical measure of it, may yet show otherwise.

Another problem concerns the nature of reality before conscious minds existed. Without anything to do the collapsing, the universe might have looked very weird – perhaps something like the many worlds interpretation of quantum theory, which holds that everything that could happen does, in an infinite number of parallel universes. According to this idea, every time a decision is made, the universe splits in two, with one outcome in one and the other in the other. Pre-conscious reality may have been a multiverse with every possible outcome happening somewhere.

### **Inanimate objects**

But not necessarily, says McQueen, because IIT rejects the idea that consciousness is exclusive to humans and other complex organisms. Even inanimate objects may possess a rudimentary form of consciousness. Indeed, consciousness itself may be a fundamental property of matter. If so, then there was no such thing as a “pre-conscious” universe.

In any case, largely for want of a better alternative, it has been impossible to erase the conscious observer from quantum mechanics. If anything, subjectivity has recently begun to reassert its centrality in the making of objective reality.

Take [quantum Bayesianism](#) or QBism, a relatively new interpretation of quantum theory. It holds that wave function collapse is caused by observers updating their knowledge. There is no objective reality, only our subjective estimation of it.

That is too much for most physicists. But for Markus Müller at the University of Vienna in Austria, it doesn’t go far enough. Müller is working on a model that suggests how an objective external world, including the laws of nature, can arise from subjective experiences. “What my approach claims is that physical reality is fundamentally observer-relative, but in an objective way,” he says.

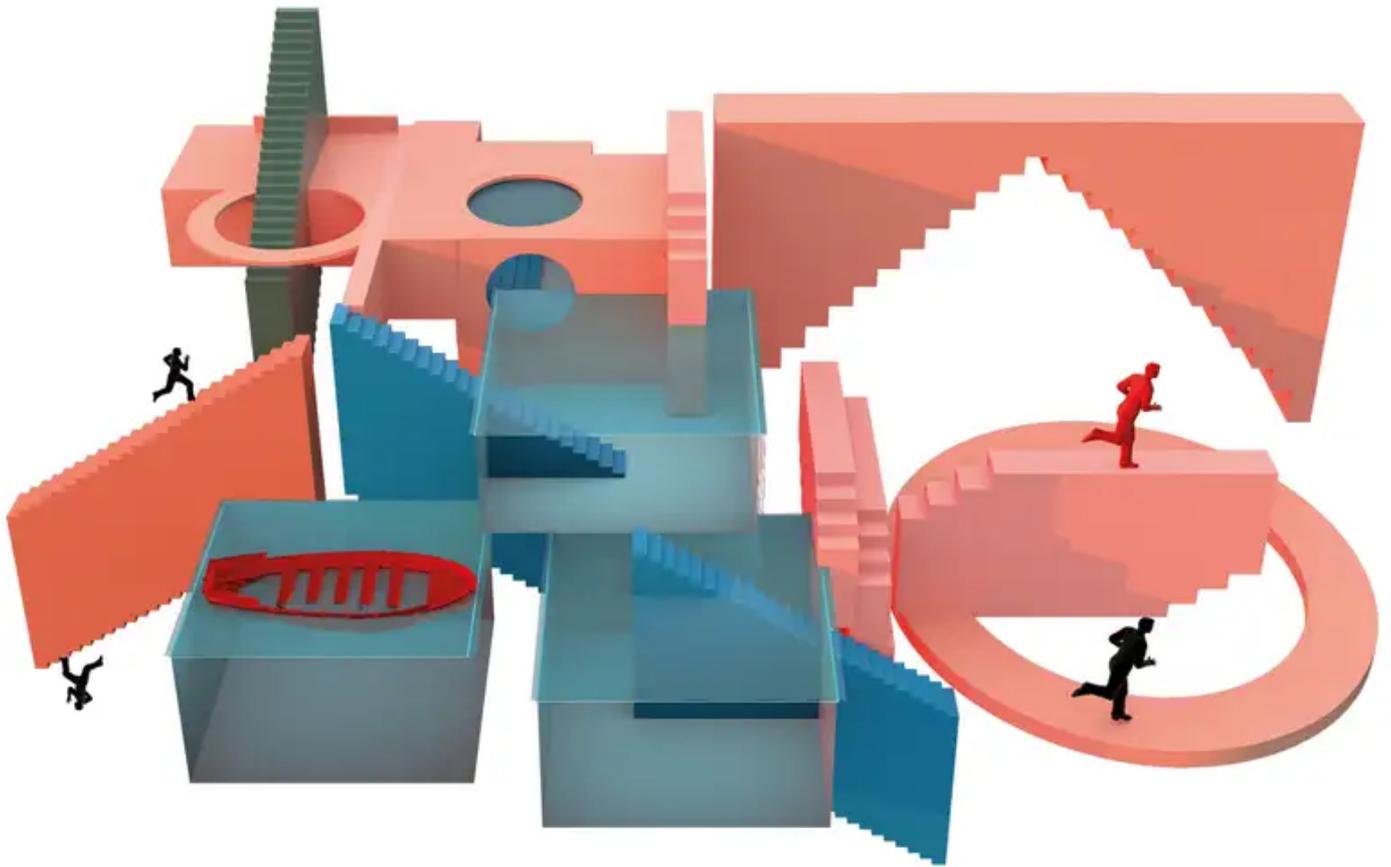
That clearly needs some unpacking. The idea is rooted in a probabilistic law used by AI researchers to help machines make predictions about the world by discovering regularities in the limited data they hold. In Müller’s approach, this “algorithmic probability” is applied in reverse: it is not the world that is fundamental but the information and the probabilistic law, which happen to give observers the impression of a physical world with consistent laws of nature.

To the extent that Müller’s ideas can be tested, the maths seems to work out, and his ideas have won praise as an unusually well-defined attempt to formulate a fundamental theory of reality from a first-person perspective.

### **“Experiences are not caused by physical reality, but compose it”**

“Müller’s proposal is extremely interesting,” says McQueen. “It effectively aims to resurrect an old idea in philosophy known as idealism, according to which experiences are not caused by a pre-existing physical reality but actually compose all the reality there is.”

Einstein wouldn't have been so generous. When the founders of quantum mechanics first raised the notion that we make reality, he pointedly asked if the moon vanishes when you turn your back. He was, however, humble enough to admit he might be wrong. "One assumes a real world existing independently from any act of perception," he wrote in 1955. "But this we do not know." We still don't, but the idea that subjective reality is all there is has to be taken as a very real possibility.



## Can we create new realities?

**Donna Lu**

IN OUR quest to understand reality, there is an elephant in the room. How do we know that the reality we are in is real? The suggestion that we could be living in a computer simulation isn't just a *Matrix*-style science-fiction idea. It is a hypothesis that has been discussed and debated by philosophers and physicists since Nick Bostrom at the University of Oxford [floated it in 2002](#). If its startling but logical conclusion is correct, it renders decades of intellectual endeavour obsolete and, ironically, takes us back to the beginning.

Bostrom's [simulation argument](#) says that if humans could one day create simulations of the universe populated with conscious beings, then in all likelihood we are living in such a computer-generated universe. The argument assumes that, eventually, enough computing power will exist to create simulations of human history that are detailed enough for the simulated people in it to be conscious. If so, then, statistically speaking, we are more likely to be living in a simulation, because simulated people would vastly outnumber unsimulated ones. That is especially true if simulated people make their own simulations ad infinitum in an endlessly nested reality.

"If it's true, it tells us something very important about our world," says Bostrom. "The very structure of reality is very different from what we assumed." These simulations will only be possible after machines surpass humans in intelligence, he says, but whether that happens in 10 years or 10,000 years, the argument holds regardless of timescale.

Or maybe it already happened and we are part of one.

Could we ever know? Some physicists have suggested that it is possible to [perform experiments to find out](#). "Basically, something happens in our simulation that could never happen in the real world," says Preston Greene, a philosopher at Nanyang Technological University in Singapore.

One idea is to look at the behaviour of the very highest-energy cosmic rays, which some physicists say are impossible to simulate 100 per cent accurately according to the "real" laws of physics. Anomalies in their behaviour could be evidence that reality isn't real.

But we should proceed with caution. Such a discovery could be catastrophic, says Greene. If our simulator overlords found out that we knew, they might just switch us off.

On a brighter note, even if we are in a simulation, it doesn't make our lived reality any less real, says Greene – it merely changes some metaphysical beliefs we have about the universe. “It doesn't change the fact that I'm sitting at a table right now,” he says. “It changes what the table is ultimately made out of.”

Instead of quarks, it would be bits. That isn't far removed from some ideas about the fundamental nature of reality, which propose that the universe is, at its most basic level, composed of information. It would also account for the mystery of its origins (see “[How did reality get started?](#)”): our universe was created by superhuman intelligence. Remind you of anything?

### **“Even if we are in a simulation, it doesn't make our lived reality any less real”**

Of course, the simulation argument doesn't provide an ultimate answer to the question “what is reality?”. Even if simulations vastly outnumber non-simulations, there is still a base level of reality in which the first simulation was or will be created. The nature of that real reality will still demand an explanation, and so the ultimate quest goes on.

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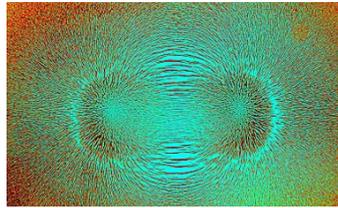
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