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# Why be conscious: The improbable origins of our unique mind

If we ask what consciousness is for, and why it evolved, we may get closer to understanding the nature of our own minds as well as those of other animals



Richard Wilkinson

By **Bob Holmes**

YOU know that you are conscious. Hopefully, you believe me when I tell you that I am, too. But is your pet dog or cat conscious? What about a tool-making crow, or a “clairvoyant” octopus or a worm? You might think it is impossible to find out. There is no distinctive pattern of brain activity that indicates consciousness, and we can’t exactly ask animals about their experiences. We don’t even fully understand what consciousness is.

But maybe there’s a way to get a handle on it. What if we tracked consciousness to its origins? Then, instead of asking what consciousness is, we ask why it evolved – in other words, what is it for? Until recently, that question has been largely ignored. But now biologists are starting to feel their way around the tree of life to consider where, when

and why something resembling consciousness emerged. Their research is proving surprisingly fruitful. It's not just shedding light on animal minds, it is also providing insights into the very nature of consciousness.

### The human universe: Does consciousness create reality?

This approach has its own difficulties. "Consciousness doesn't leave any fossil record," says Anil Seth, a neuroscientist at the University of Sussex, UK. So we have to infer its evolutionary history by comparing animals alive today and working back to what their common ancestor might have been able to do. And, because we don't really know what we are looking for, we have to grope our way blindly around the evolutionary tree, with only our own experience of consciousness as a guide. Then, as we observe how consciousness is, or might be, expressed in other animals, we can gradually refine our notion of what we are talking about.

Some signs seem obvious. Chimpanzees recognise themselves in the mirror. Scrub jays will sneak back and re-cache food if another bird watched them hide it the first time – unless the watcher is their mate. Rats that push the wrong lever and fail to get a food reward gaze regretfully at the lever they should have pushed. In these cases, we can infer some sort of awareness of self, of others, and of what might have been, which looks a lot like what we recognise in ourselves as consciousness. If this were the sole criterion, however, there would be precious few non-human animals that cleared the bar.

### **"Consciousness comes with drawbacks. It may be less helpful than we think"**

There's reason to consider a broader benchmark: not every conscious experience is that complex, even for us. "If you ask yourself, what are you conscious of... you see colours, you smell coffee, you feel your aches and pains," says Jesse Prinz, a philosopher at the CUNY Graduate Center in New York. "Consciousness looks like it's largely about perception and emotion: it's not about thought or higher more human capacities." These basic components of conscious experience could be widespread, even in animals that lack our mental sophistication and brainpower. Let's push a little deeper into the family tree, to see if we can find them.

Consider emotion, or "hedonic valuation" to use a less anthropocentric term. As Prinz points out, much of our conscious experience consists of perceptions with shades of feeling – objects are comforting or scary, sounds are pleasing or annoying, our body feels good or bad. And such evaluations play a crucial role in guiding our behaviour.

"Behaviour is about moving toward what is beneficial or moving away from what isn't. Feelings are meant to guide us by offering positive and negative rewards," says evolutionary biologist Bjørn Grinde at the Norwegian Institute of Public Health in Oslo. That makes hedonic valuation a useful evolutionary tool.

## Metaphysics special: What is consciousness?

Grinde believes this sensation – the awareness that something good (or bad) is happening to me – may represent the dawn of consciousness. So, which animals have it? Surveying the vertebrate family tree, he sees a clear pattern: mammals, birds and reptiles all show signs of emotional responses, such as an increased heart rate and elevated body temperature when handled, while fish and amphibians do not. The brains of higher vertebrates are also much richer in receptors for dopamine, the neurotransmitter most closely associated with reward pathways. He believes this is evidence that the ability to assign value to an experience arose around 300 million years ago in the common ancestor of modern reptiles, birds, and mammals – the first fully terrestrial vertebrate.

It makes sense. This ancestor would have faced challenges that its aquatic cousins did not, like temperature regulation and water conservation. Simple animals have reflex responses, and even a worm can learn a fixed behaviour pattern by trial and error, but an individual with hedonic valuation is capable of much more flexible behaviour. In this new environment, such adaptability would have been a big advantage. However, as Grinde points out, consciousness also has drawbacks. Compared with unconscious processing, it is slow and energy intensive, and can only do one thing at a time. What's more, it can lead to behaviours that are capricious or even detrimental to the individual – for example, there would be no self-harm without conscious thought. So the evolution of consciousness may be less helpful than we tend to think, leading Grinde to speculate that it emerged just once.

### Do fish have feelings?



I'm probably conscious, me, and have been for around 290 million years

Georgette Douwma/Nature PL

Other researchers agree that land vertebrates have something special, but many believe consciousness is found elsewhere in the animal kingdom too. They point out that the signs of emotion become harder to discern the further we get from ourselves. Would we recognise the expression of feelings in a fish, let alone a fruit fly? Instead, many researchers are converging on another indicator: an animal is conscious, they propose, if it experiences the world subjectively. This captures the distinctive “me, here, now” element of our own experience. Like hedonic valuation, subjective experience allows behavioural flexibility that goes beyond mere reflex responses. But it doesn’t necessarily involve any of our more sophisticated abilities like emotion, reason or imagination.

That sounds like a plausible basis for consciousness, but how can you measure an animal’s subjective experience? Bruno van Swinderen thinks he has found a way. A neuroscientist at the University of Queensland in Brisbane, Australia, he believes the essence of subjectivity is selective attention – focusing on just a few elements among all the sensory information available – because it indicates an individual is taking control of its perception. “I’m not sure there’s really much difference between subjective experience and selective attention,” he says.

### **Read more: Consciousness – Why aren’t we all zombies?**

To discover whether fruit flies are capable of selective attention, van Swinderen trained them to walk on a trackball suspended on a cushion of air, in front of a virtual scene projected onto a wrap-around wall of LEDs. By rotating the trackball, the flies could shift the scene and choose which of two objects to pay attention to. The images flickered at different rates, so that when a fly was paying attention to a particular object, it produced telltale frequencies in its neural activity, recorded by probes implanted in its brain. The results were remarkable. “It’s like a spotlight. There’s a dynamic window of attention that’s moving around, and other competing objects are being suppressed,” he says. “The small fly brain really has a capacity for attention. That is, to me, the dawn of consciousness.”

Measuring attention like this is very labour-intensive. But van Swinderen thinks there may be a rough-and-ready way to separate animals that pay attention from those that cannot. “An easier experiment might be to see which organisms need to sleep,” he says. “So far, it really seems like the animals that pay attention are also the ones that need to sleep.” These include vertebrates, insects, crustaceans and octopuses, but probably not more lumpen animals such as starfish, worms, and jellyfish. Intriguingly, van Swinderen has also found that insects and vertebrates respond almost identically to general anaesthetics. “The concentration to knock out a fly is pretty much the same as the concentration to knock out an elephant,” hinting that the two lose consciousness in a similar way, he says. By contrast, nematode worms, which are unlikely to have selective attention or anything approaching consciousness, require 10 times as much anaesthetic before they stop moving.

## **“The animal kingdom is suffused with other kinds of consciousness”**

The hunt for selective attention suggests that something like consciousness occurs in

vertebrates, insects and octopuses at the very least. We know that the common ancestor of these three groups was a very simple organism that resembled a flatworm. Modern flatworms show few, if any, signs of rudimentary consciousness, so it seems a safe bet that the common ancestor also lacked consciousness. If so, that means consciousness evolved separately in the three groups. This runs counter to Grinde's proposal, but does reinforce his idea about the function of consciousness. "When you step back and start to reflect on why these systems arise where they do, the story seems to make sense," says Prinz. All three groups feature nimble, fast-moving animals that encountered rapidly changing conditions as they moved. That puts a premium on flexible decision-making.

However, not everyone is convinced that being able to direct focus is a signifier of consciousness. Selective attention is about data handling, says Michael Graziano, a neuroscientist at Princeton University in New Jersey. To act on that data, an animal needs a mental model of that attention, for much the same reasons it needs a mental model of its body. "It's fine for me to say 'arm, go here'," says Graziano. "But something in my brain needs to have a model of what an arm is, its possible motions, and so on." Similarly, a model of attention would recognise that you are focusing on something and understand how quickly you can shift focus and so forth. This model – not selective attention per se – is responsible for our conscious awareness of the world, according to Graziano. And he speculates that such a level of mental sophistication may only be found in vertebrates.

Evolutionary biologist Eva Jablonka at Tel Aviv University, Israel, also thinks there is more to consciousness than selective attention. She believes we should be looking for "unlimited associative learning" as a marker for the origin of consciousness. This is the ability to knit multiple cues into a single perception that is more than the sum of its parts, and then use that compound cue to drive behaviour. It's what allows us to learn that a growling dog may be playful in one context but threatening in another. "That marks the beginning of minimal consciousness," she says.

## Explosive talent

Unlimited associative learning requires an array of brain functions, not only selective attention, but also the ability to combine sensations into one perception, perform compound action patterns and distinguish between self and environment. Scientists have found evidence that this complex learning is surprisingly widespread throughout the animal kingdom. Already, researchers have documented it in almost every vertebrate (except, possibly, lampreys), some arthropods such as insects and crustaceans, a few molluscs including octopuses and, perhaps, some snails. The jury is out on other groups, such as worms, since we don't have enough evidence to be sure. "There are huge gaps in our knowledge," says Jablonka.

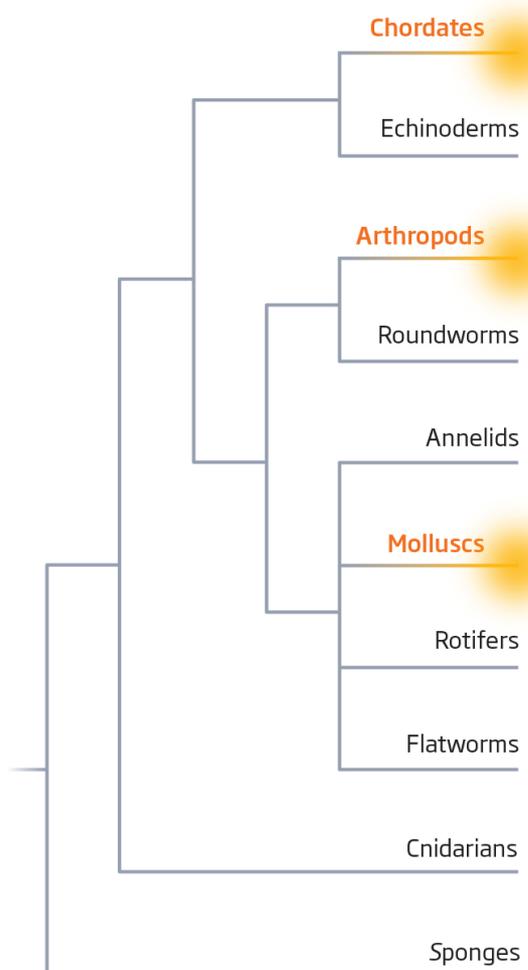
Nevertheless, what we already know has led Jablonka to suspect that consciousness evolved in early vertebrates and early arthropods during the Cambrian explosion, about 540 million years ago, when these groups diversified rapidly. (Consciousness in octopuses probably evolved about 250 million years later, after their lineage diverged from other, less intellectually gifted molluscs such as clams and snails.) This origin is interesting. The Cambrian explosion saw the emergence of most of the major animal groups alive today, and Jablonka suggests that consciousness – driven by selection for powerful learning ability – might have helped drive that rapid evolution. "I can't think of many things that could change adaptability that dramatically," she says.

## Consciousness: Our silent partner, the unconscious

It's early days when it comes to considering consciousness in an evolutionary context. While researchers have yet to reach a consensus on when it arose and which animals possess it, they have already enriched our understanding of what consciousness is. There's no doubt that human consciousness is special. Whether it is unique in some way or simply richer than that of other animals is still up for debate. However, it is becoming clear that the rudiments of consciousness are all around us. That comes as a surprise to many. "When I started, I was really sure we would find it in mammals. I was pretty convinced we wouldn't find it elsewhere," says Prinz. "I have been absolutely convinced that the contrary is true. The basic mechanisms can be found in creatures of an enormous variety."

### The enlightened ones

Signs of consciousness have been found in animals from at least three different **phyla**, suggesting it evolved more than once and is far more common than most people think



Another lesson we can draw from this approach is that consciousness is not clear-cut. "I don't think we're ever going to find a single dividing line between those species that enjoy the glow of an inner universe and those that don't," says Seth. "There is not just

one single way of being conscious. The animal kingdom is going to be suffused with other kinds of minds and other kinds of consciousness, and they're not going to be just mini versions of human consciousness. We're not the centre of the universe."

## 10 signs of consciousness

Not sure whether an animal is conscious? Here are some clues to look out for:

- Recognises itself in a mirror
- Has insight into the minds of others
- Displays regret having made a bad decision
- Heart races in stressful situations
- Has many dopamine receptors in its brain to sense reward
- Highly flexible in making decisions
- Has ability to focus attention (subjective experience)
- Needs to sleep
- Sensitive to anaesthetics
- Displays unlimited associative learning

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