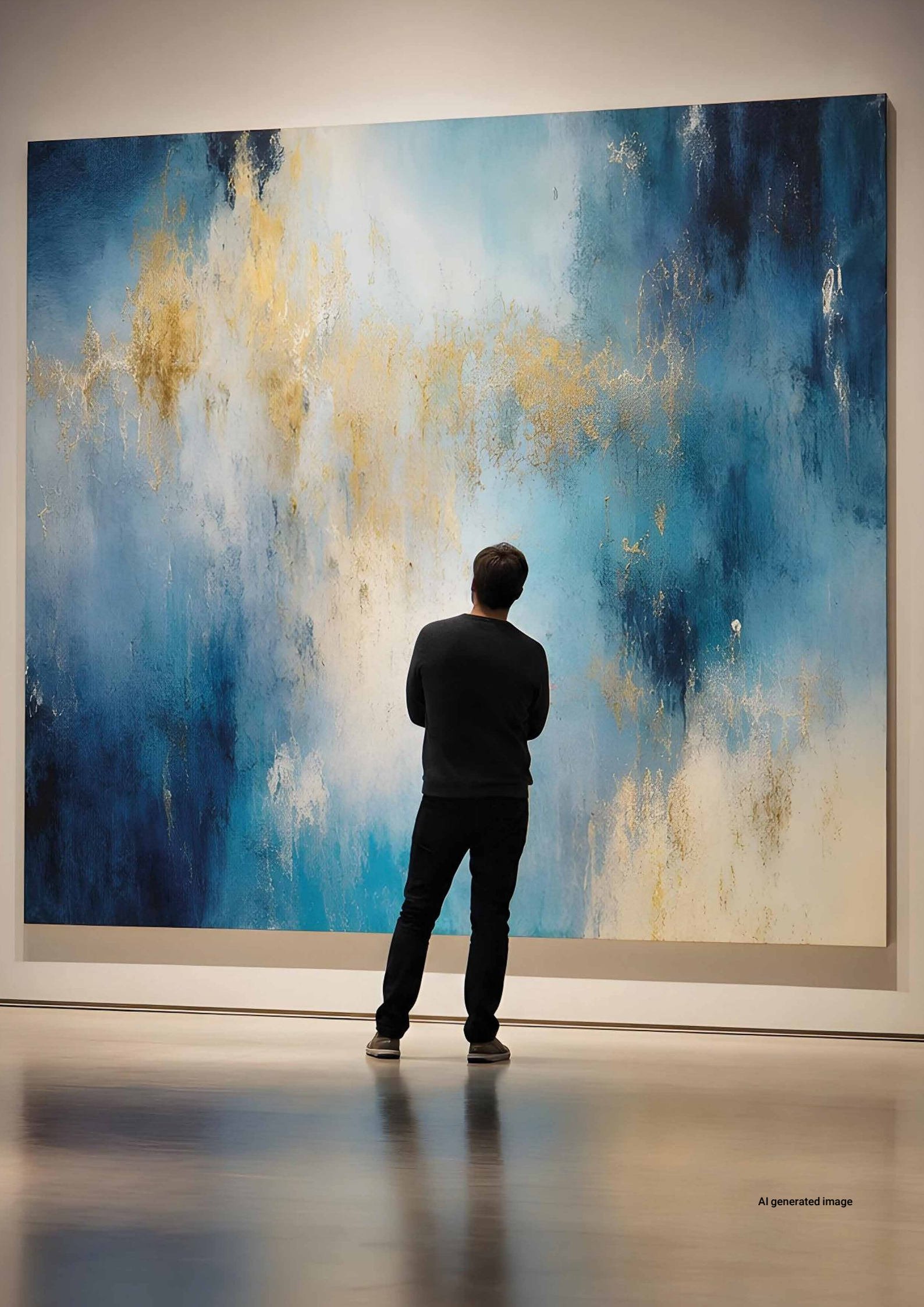
A SENSE OF BEAUTY INSCRIBED IN NEURONS

How come one painting can catch our attention while the other does not impress us in the slightest? What makes us tear up when hearing a couple of sounds arranged in a certain order? Even though art might seem to be the domain of imagination and subjective experiences, its reception has a biological dimension as well. Each encounter with a piece of art lights up in our brains a complex network of processes responsible for perception, attention, memory, and emotion. Neurons in our brains analyse shapes, colours, and proportions and compare them to those we have experienced previously to then make sense of them and assign them a certain meaning. What's created is something more than just an image or a sound – it's an aesthetic experience.



Agnieszka Sikora, PhD

Jacek Francikowski, PhD
Institute of Biology, Biotechnology and Environmental Protection
Faculty of Natural Sciences
University of Silesia in Katowice
jacek.francikowski@us.edu.pl



AI generated image

Researchers have been studying the processes taking place in the human brain while experiencing art for decades. Thanks to modern imaging techniques, they can now track the activity of specific areas of the brain and gain a better understanding of why some works of art appeal to almost everyone, while other resonate only with a select audience. Is there a neuronal recipe for beauty? And what can brain studies teach us about ourselves?

'The creation and perception of abstractions fall within that sphere of the mind's functioning which we regard as particularly subjective. While reception, i.e. what we perceive and how we perceive it, as well as emotional or motor responses to specific stimuli, is relatively easy to study, it is much more difficult to grasp what happens 'inside', at the level of interpretation and assigning meaning', explains Jacek Francikowski, PhD, a biologist at the Institute of Biology, Biotechnology and Environmental Protection at the Faculty of Natural Sciences of University of Silesia in Katowice.

BEGINNINGS

If we are to answer the question of when humans first began to create art, we must first determine what we understand art to be. Might it be the abstract marks, patterns and symbols engraved on the tools of early humans? Or perhaps figurative depictions of animals, humans, or items painted on cave walls? Were these images intended to depict the world, or did they tell specific stories, such as those of hunts? The definition of art will change depending on how we answer these questions. Generally, we can assume that it is a type of human creation, which evokes aesthetic, emotional, or intellectual experiences by means of images, sounds, words or other ways of expression.

Particularly noteworthy are the depictions coming from the Blombos cave (Republic of South Africa). Pieces of ochre were found there, covered with regular, geometric patterns carved by humans around 75,000–100,000 years ago. Some researchers see them as the earliest manifestations of abstract art or at least of symbolic thinking.

In turn, first images depicting reality are dated to around 45,000 years ago, e.g. the painting of a wild pig discovered on the island of Sulawesi in Indonesia. This was a monumental discovery because for decades the consensus was that the figurative art had its beginnings in Europe – in such caves as Lascaux or Chauvet. What is interesting, Spanish caves contain paintings that may be over 64,000 years old, suggesting that they were created before Homo sapiens appeared in Europe. If the dates are correct, this means that Neanderthals were creating art or at least symbols.

From a neuroscientific perspective, these findings are particularly interesting because the earliest evidence of human artistic creation testifies not so much to manual skills as to something far more significant: the emergence of the ability to create and understand symbols. Many neuroscientists regard this very ability as the foundation of art, language, religion, and science alike.



Cave painting from the Chauvet Cave | Photo: Thomas T., CC BY-SA 2.0, via Wikimedia Commons

ARE HUMANS THE ONLY ONES TO EXPERIENCE BEAUTY?

For a long time, the prevailing view in academia was that aesthetic experience is a uniquely human characteristic and occurs when people interact with sensory objects with a particular mindset. However, contemporary research shows that basic mechanisms responsible for aesthetic assessment can also be present in animals. This does not, of course, mean that a chimpanzee becomes captivated by Impressionist paintings or that a wolf ponders the architecture of a Gothic cathedral. But it is likely that many species possess the ability to evaluate the stimulus in terms of its attractiveness and harmony or their aesthetic preferences. A good example is bowerbirds (*Ptilonorhynchidae*). Males use sticks to build complicated structures, i.e. bowers. They decorate them with colourful items: flowers, shells, fruit and even bits of plastic. Females choose their mates based on the attractiveness of those structures. Peacocks and certain fish also exhibit similar behaviour; in these species, mate

selection depends on the assessment of colours, symmetry, patterns and complex displays of movement. Charles Darwin himself suggested that the attractiveness may have emerged in evolution earlier than in humans and played an important role in sexual selection.

Then, what is the difference between human and animal sense of beauty? As researchers point out, this probably does not concern the experience of aesthetic pleasure itself, but rather its interpretation. Humans do not merely react to beauty – they are also able to ponder its meaning, relate a work of art to their own experiences, recognise symbols and metaphors, and experience art as a source of reflection on the world and on themselves.

WHAT HAPPENS IN THE BRAIN OF A PERSON EXPERIENCING ART?

Research shows that encountering a work of art does not activate a single, specific 'beauty centre' in the brain. Instead, several interconnected regions spring into action – from those handling basic visual or auditory signals to the emotional circuit, the pleasure-driven reward system, and the networks that process memory, meaning, and interpretation.

In short, when we take in a painting or listen to a piece of music, the brain isn't just 'seeing' or 'hearing'. It is constantly evaluating whether what we are experiencing is interesting, pleasing, surprising, familiar, or significant. Our sense of beauty seems to emerge from a dynamic interplay between perception, emotion, and cognitive appraisal.

'Everything we experience, including our encounters with art, is rooted in how the brain processes information. It involves both incoming sensory data and the internal resources our brains already hold: our knowledge of the world, past experiences, beliefs, and ingrained cognitive patterns. How we respond to art is always a product of these elements coming together', explains Jacek Francikowski.

The prefrontal cortex plays a pivotal role here, orchestrating higher cognitive functions like experiencing stimuli, synthesising information, and weighing up its significance. It is in these regions that much of the groundwork for interpretation and subjective experience takes place. 'When studying how people perceive art, we see activity across emotional centres like the amygdala and insula, and structures responsible for the evaluation and integration of information, including the prefrontal cortex. At the same time, lower-level processing areas are also involved, i.e. those responsible for the basic analysis of visual, auditory, and tactile inputs', explains the biologist. 'In the case of complex art forms, such as theatre and opera, we are additionally dealing with the integration of multiple sensory modalities (senses) and narrative layers. The brain must simultaneously process visual imagery, sound, movement, and plot, making the whole experience vastly more complex'.

Blind people present an interesting case. Even though their appreciation of art relies mainly on auditory and tactile modalities, research shows that the visual cortex may be activated even without sight. This means that regions originally dedicated to the processing of visual input appear to be repurposed, taking on tasks like processing of spatial information or mental imagery.

'This does not, however, mean that the brains of blind people "see" in the same way as those of sighted people. Rather, they create different, specific forms of mental representation that cannot be directly compared with visual experience. It's a striking demonstration of the brain's flexibility – its ability to reorganise its own functions, known as neuroplasticity', adds the scientist.

Only a few decades ago, scientists thought that the mature brain was not subject to significant change, and that its ability to form new neural connections was very limited. Today, we know the brain rewires itself throughout our lives: building new connections between neurons, strengthening some neural networks while pruning others, and occasionally even reassigning entire regions. This neuroplasticity allows us to learn new skills, adapt to a changing environment, and recover function after injury. It also fundamentally shapes how we engage with art. Every encounter with a creative work leaves an imprint on our neural wiring, enriching our perspective and altering how we process future stimuli. This is why an art historian, a professional musician, and someone with no prior exposure to a particular art form can come in contact with the exact same painting or a piece of music and walk away with entirely different experiences. Shaped by different backgrounds, their brains have created distinct patterns of perception, association, and emotional response.

It is worth noting that beyond cognitive and emotional benefits, engaging with art may also support our long-term health. Keeping the mind actively engaged and regularly stimulated over a lifetime is linked to a slower rate of cognitive decline in later years. Research suggests that diverse intellectual and sensory pursuits – art included – help build so-called cognitive reserve, i.e. the brain's ability to compensate for neurodegenerative changes. While these do not guarantee protection against such conditions as dementia, they may delay the onset of symptoms and soften their impact.