

Is Plant ‘Intelligence’ Just a Human Fantasy?



Sofia Quaglia

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Although plants make up over 80% of the biomass on Earth, for centuries they have been thought of as inanimate and passive things. Researchers even coined the term “plant blindness” to refer to a cognitive bias that literally makes our brains zone out plants in our view and underestimate their importance.

But as research into the plant world has blossomed over the past 40 years, thanks in part to new biotechnologies allowing scientists to study gene expression, scientists are discovering how truly alive plants are. Even as new revelations change our knowledge of plant abilities, though, the debate on whether plants can be considered sentient remains contentious.



Illustration: Benjamin Currie/Gizmodo

“I think plants are massively taken for granted. I think they are extremely sophisticated organisms. They are adapting exquisitely well to the changes around them all the time,” Claire Grierson, a plant biologist at the University of Bristol, told Gizmodo. “I think we can learn a hell of a lot from plants philosophically.”

Scientific research into plant cognition dates back to Charles Darwin, who would draw parallels between plant roots and the brain. Ever since, studious circles around the world have taken a leaf out of his book, from the controversial publishing of *Secret Life of Plants* in the 1970s, which goes as far as saying plants can read human minds, to Daniel Chamowitz’s 2013 book *What a Plant Knows*, which explores how plants’ acute senses teach them about the world.

Although no plant has a central nervous system, some researchers are exploring the field of neurobiology in botany. The International Laboratory of Plant Neurobiology (LINV) in Florence, Italy argues that having a brain should not be a prerequisite for intelligence. “We firmly think that all the behaviors observed in plants, which look very much like learning, memory, decision-making, and intelligence observed in animals, deserve to be called by those same terms,” the LINV website reads.

Plants are conscious, according to LINV director Stefano Mancuso, an arboriculture professor at the University of Florence. Mancuso’s case for plant consciousness hinges on evidence that they are aware of their existence, of their surroundings, and of the passing of time. Among other things, Mancuso quotes the renowned physicist Michio Kaku and argues that, if consciousness is the ability to build a model of yourself in relationship to space, others, and time, then plants therefore must be conscious, because of their sensitivity to chemical and physical stimuli, to their competitors, and between themselves. Plants even deserve rights, Mancuso writes in his book *La Nazione Delle Piante*, where he drafts out an eight-article plant constitution for the “only, true and eternal powerful nation of the planet.”

Intriguing but controversial studies into plant consciousness have been conducted by Monica Gagliano, a researcher in plant behavior at the University of Sydney. In 2014, Gagliano tested the *Mimosa pudica* (nicknamed the “shy plant” or “sensitive plant”) for its ability to change its threat response—curling its leaves—after multiple false alarms.

Researchers dropped the plant repeatedly until it eventually “learned” there was no real threat and stopped curling its leaves, at least in the team’s interpretation. According to the study, the plants retained this learned information for months after the experiment, suggesting memory longer than some animals. In 2016, Gagliano also conducted a study showing that the garden pea (*Pisum sativum*) is capable of associative learning, predicting one thing according to an associated cue, which is a complex cognitive ability few animals boast.

However, some scientists have proposed different interpretations of Gagliano’s findings, for example, suggesting that the plant’s sensitivity reduced for a reason other than learning (like overstimulation) and arguing that the *Mimosa pudica* experiment has yet to be replicated. It’s likely that a researcher’s predisposition to see plants as intelligent—or not—affects how they interpret the findings of these kinds of studies, with plant neurobiology being heavily criticized by some members of the scientific community.

In fact, not all academics feels comfortable drawing comparisons between humans and plants. Last year, a group of scientists published a downright exasperated paper challenging the increasingly common view that plants possess consciousness. It’s title says it all: “Plants Neither Possess nor Require Consciousness.”

“In claiming that plants have consciousness, ‘plant neurobiologists’ have consistently glossed over the remarkable degree of structural and functional complexity that the brain had to evolve for consciousness to emerge,” the paper reads. The lead author of this research, biologist Lincoln Taiz from the University of California at Santa Cruz, wrote: “There is no evidence that plants require, and thus have evolved, energy-expensive mental faculties, such as consciousness, feelings, and intentionality, to survive or to reproduce.”



Mimosa pudica, also called the “touch-me-not plant,” will curl its leaves inward in response to touch.
Photo: [File:qen/Wikimedia Commons](#)

“There is a replacement for the word ‘intelligence,’ and that replacement is called ‘adaptive behavior.’”

For some, the consciousness argument boils down to semantics. Whether we use words like smart, intelligent, clever, or even conscious and reflective, it all comes down to what we mean by those words and how we understand them as they are attributed to humans.

“Depending on how you define consciousness or intelligence, you could have a definition that would include what plants do, or you could have a definition that wouldn’t,” Grierson told Gizmodo. “Plants use a huge proportion of their genes to sense their environment, make decisions about how best to look after themselves and act on them. Whether this is ‘consciousness’ or ‘intelligence,’ I can’t say, but it is certainly complex and interesting.”

Some researchers argue that trying to apply the vocabulary of animals to plants is inherently misleading.

“Though many analogies to metazoan behaviors and ‘consciousness’ can be made, plant behaviors are simply different from animal behaviors,” Mannie Liscum, a biologist at University of Missouri, told Gizmodo. “This doesn’t make plants any less fascinating. The need to anthropomorphize plants is completely unnecessary.” Liscum argues that phrases like plant neurobiology are “nice, cute terms” and good metaphors for teaching purposes, but they can be deceptive: Plants cannot have neurobiology because they do not have neurons, period.

"I think once you give them the ability to think like an animal or like a human, actually then a lot of...how really complicated and cool plants are, that just disappears, right?" Liscum said.

Words like cognition, intelligence, and consciousness are ones that humans use to describe human capabilities. "And probably it's not a good idea to use those words as we think of their meanings for plants, because plants just aren't doing the same thing since we are," Elizabeth Van Volkenburgh, a plant scientist at University of Washington, told Gizmodo.

"There is a replacement for the word 'intelligence,' and that replacement is called 'adaptive behavior'," Van Volkenburgh, who has served as the president of the Society for Plant Signaling and Behavior, told Gizmodo.

In fact, plants' brilliant complexity stands in their talent to perceive the environment they are in and adapt to it in the most efficient way, skills they've evolved over millennia because they cannot get up and run away from a threat or go get themselves food. Various research has found evidence that plants can tell time and sense temperature, moisture, rain, magnetic fields, windiness, shade, acidity, competition below and above ground, what's attacking them, and more; and they respond to all of these inputs using a multitude of extra- and intracellular signals, through gene expression and chemical changes.

"Plants are a lot more sensitive to their environment than most animals are, to be quite honest," Liscum tells Gizmodo. "And they have to be, because every one of those signals could potentially be crucial."

Whilst humans have five senses, plants may have up to 20, and that number could be "much, much higher," Van Volkenburgh told Gizmodo. For instance, plants have a sense of smell, but if we were to count how many different volatile compounds plants can recognize, what information they process from them, and how they can respond, their sense-count might be up in the hundreds. In fact, plants actually communicate between themselves by perceiving and releasing volatile compounds through air & soluble compounds through soil: for example, they coordinate ripening by sensing whether their neighbors are ripening via their emission of ethylene. That smell of freshly cut grass is actually a distress signal.

Plants sense threats and danger by recognizing physical touch and reacting to various chemicals. An October 2019 study conducted at Lund University confirms previous research that plants get "stressed" from touch, releasing damage-repairing chemicals such as jasmonate, gibberellic acid, and calcium. Olivier Van Aken, a plant biologist at Lund University, told Gizmodo that there are genome-wide changes in the arabidopsis plant even when it is just sprayed with water. "Several thousands of genes go up within 20 minutes of being sprayed, and most of them come down by one hour after the treatment. It's like an alarm bell response," Van Aken told Gizmodo. Research has also shown that some plants activate their chemical defenses, such as levels of glucosinolate and anthocyanin, when they sense the vibrations caused by a caterpillar munching on plants near them.

According to May 2020 research at the Tokyo University of Sciences, some plants (arabidopsis, tobacco, and cowpea) also analyze predators' secretions, such as saliva from a caterpillar on a leaf. Plants sense specific molecules from predators and respond accordingly, the lead author of this paper, professor Gen-ichiro Arimura, told Gizmodo. In the case of corn seedlings, the reaction means emitting molecules that attract parasitic wasps, the caterpillar's enemy, to drive them away.

"All organisms must have great strategies that have enabled them to have survived for thousands or millions of years. If not, they would have simply been exterminated," Arimura said. "Thus, I would prefer to say 'immovable plants are robust' rather than 'they are intelligent.'"

In fact, it might be hard to prove whether plants can learn and memorize or purposefully unlearn and forget, but some researchers argue that their “epigenetic memory,” one ingrained in their genes, is enough for plants to hack many recollective situations. Epigenetic memory is used to pass on information to plant offspring, arguably similarly to how cultural memory is used in human populations. A May 2020 study found evidence that when plants produce seeds, they erase proteins carrying information about stressful environment conditions experienced by the parents (such as cold) so that the seeds can travel to new environments and adapt seamlessly. The plant’s genetic system is almost remembering what to forget.

Grierson, who is the lead author of the 2011 paper One Hundred Important Questions Facing Plant Science Research, said that as she nears the 10-year audit of that report, so much has already changed completely. “While we have made quite a lot of progress,” Grierson said, “we often find a new question that we either didn’t know was coming or that turned out to be much more important than we anticipated.”

As new technologies and research strategies become available to study plants, the debate over plant intelligence may be settled—or it could be inflamed even further, as scientists have increasingly complex data to interpret. As researchers look into novel molecular, genetic, imaging, and artificial intelligence technologies, even more questions in plant science could arise. The biggest hurdle may continue to be our humans biases: We see what we want to see, whether that’s a sensitive, conscious organism or merely a beautiful chain of chemical reactions.

Sofia Quaglia is an Italian journalist based in New York City. She covers all things science, from public health systems to the latest discoveries in marine biology. Her work has appeared in Inverse.com, Psychology Today, Quartz, and more. As a News Analyst for NewsGuard Technologies, she fact checks and debunks fake health and science news.

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