INDEX

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PRESS RELEASE

The Florence Experiment, by Carsten Holler & Stefano Mancuso
A project to explore the relationship between plants and humans
Florence, Palazzo Strozzi 19 April–26 August 2018
www.palazzostrozzi.org / @palazzostrozzi / #FlorenceExperiment

This spring-summer Palazzo Strozzi will host *The Florence Experiment*, a new site-specific project devised by celebrated German artist Carsten Höller and plant neurobiologist Stefano Mancuso, curated by Arturo Galansino, Fondazione Palazzo Strozzi Director General.

Connecting internal and external spaces of the famed Renaissance palace, *The Florence Experiment* will comprise two experiences – monumental, intertwined slides will spiral visitors down a height of twenty metres, and a 'live' analysis of the impact of human emotion on plant growth. The project has been designed to further our understanding of ecology – not only as respect for nature, but as the awareness of empathy between man and his botanical environment.

Some of the visitors will be handed a plant to accompany them as they slide down from the loggiato to the Palazzo Strozzi's courtyard. To exit, the visitor will then pass into a laboratory where scientists will measure their plant's photosynthetic parameters and volatile molecules, as triggered by the emotions experienced in the descending visitor, and picked up by their plant.

Located in the basement of Palazzo Strozzi, the laboratory will also house special cinema theatres, one screening scenes from famous comedies, the other excerpts from renowned horror films. The audiences' contrasting reactions will produce different volatile chemical compounds, which will travel through a system of pipes and tubes to the façade of the Palazzo. Outside, the impact of these compounds and their effect on the growth of *Wisteria* plant vines, arranged to climb up a series of wires in the form of 'Y's', will become increasingly apparent over the summer months. The impact of the public's fear or amusement is expected to visibly influence the direction in which the plants grow, thus creating a plant graph illustrating the interaction between human emotions and plant behaviour.

Höller has worked as an entomologist before becoming an artist and holds a phD in pythopathology. Expanding on his increasingly interactive practice, this unique project has been devised with Prof. Dr. Stefano Mancuso, a founder of the study of plant neurobiology - which considers the complexity and intelligence of plants, with the capacity to communicate through the perception and emission of chemical compounds.

The Florence Experiment aims at creating a new awareness of the way in which we see, understand and interact with plant life, turning Palazzo Strozzi's façade and courtyard into fully-fledged areas of scientific and artistic experimentation with regard, mirroring the Renaissance's values of the alliance between art and science.

"With this project, so courageous and so special" comments Arturo Galansino, *"Palazzo Strozzi will become a site of real contemporary experimentation and reflection, turning an architectural Renaissance masterpiece into a workshop of dialogue between art and science. Cooperation with Carsten Höller, one of the most important artists on the international scene, and with Stefano Mancuso, a Florentine scientist known worldwide for his work on plant neurobiology, offers us a spectacular opportunity to further Palazzo Strozzi's calling as a multidisciplinary space seeking to find ever new routes to involve and interacting with our visitors".*

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The project is promoted and organised by the Fondazione Palazzo Strozzi with the support of the Comune di Firenze, the Camera di Commercio di Firenze, the Associazione Partners Palazzo Strozzi and the Regione Toscana, and with a crucial contribution from the Fondazione CR Firenze.

Notes to Editors
Fondazione Palazzo Strozzi
Established in July 2006, the Fondazione Palazzo Strozzi is an independent public-private foundation who delivers a consistent high-quality programme of modern and contemporary art exhibitions in its landmark Renaissance building, the Palazzo Strozzi. The Foundation has marked a significant break in the way cultural institutions have been run in Italy, establishing itself as a leading art venue in Italy and Europe.

Fondazione Palazzo Strozzi

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FACT SHEET

Title	*The Florence Experiment*
Venue	Palazzo Strozzi
Period	19 april-26 august 2018
Project by	Carsten Höller, Stefano Mancuso
Curated by	Arturo Galansino
Promoted and organised by	Fondazione Palazzo Strozzi
With the support of	Comune di Firenze, Camera di Commercio di Firenze, Associazione Partners Palazzo Strozzi, Regione Toscana
With the contribution of	Fondazione Cassa di Risparmio Firenze
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With the collaboration of	Area Cinema di Fondazione Sistema Toscana
Technical Sponsor	Ferrovie dello Stato Italiane, Ataf gestioni, Busitalia-Sita Nord, Feltrinelli, Ufficio Turismo Città Metropolitana di Firenze, Toscana Aeroporti SpA, Unicoop Firenze, Firenze Parcheggi, La Rinascente
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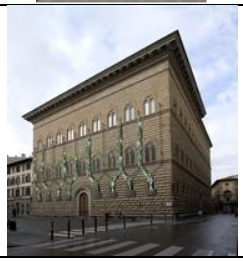
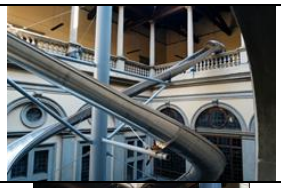
Catalogue	Marsilio Editore
Bookings	Sigma CSC T. +39 055 2469600 F. +39 055 244145 prenotazioni@palazzostrozzi.org
Opening hours	Daily 10.00-20.00, Thurdsay 10.00-23.00. Last admission one hour before closing. *The Florence Experiment* will not be accessible from 23 to 25 July
Info	T. +39 055 2645155 www.palazzostrozzi.org
Admission	Full € 5,00; reduced € 4,00; schools € 3,00. Special joined ticket with the exhibition *Dawn of a Nation. From Guttuso, to Fontana and Schifano* Full € 14,00; reduced € 11,50; Schools € 6,00

WARNING: To take part in the project you must first read and agree to the terms and conditions posted in the ticket office and on our website www.palazzostrozzi.org. Please note that children must be at least 6 years old, between 130 cm (4' 3") and 195 (6' 5") tall and weigh no more than 120 kg (18 st. 12 lbs; 264.5 lbs) to take part in the project. An accompanying adult must sign a waiver for minors under the age of 14.

PHOTO SHEET

High resolution images can be downloaded from the press area of www.palazzostrozzi.org

	THE FLORENCE EXPERIMENT RENDERING	
1	*The Florence Experiment Slides*, 2018 (Rendering by Michele Giuseppe Onali)	
2	*The Florence Experiment Slides*, 2018 (Rendering by Michele Giuseppe Onali)	
3	*Plant Decision-Making Based on Human Smell of Fear and Joy*, 2018 (Rendering by Michele Giuseppe Onali)	
	THE FLORENCE EXPERIMENT WORK IN PROGRESS	
4	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	
5	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	

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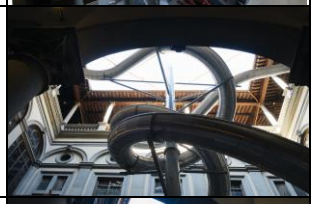
6	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	
7	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	
8	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	
9	*The Florence Experiment, 2018* (Photo by Martino Margheri)	
10	*The Florence Experiment*, 2018 (Photo by Martino Margheri)	
11	*The Florence Experiment*, 2018 (Photo by Attilio Maranzano)	

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12	*The Florence Experiment*, 2018 Analysis Laboratory, Strozzina (Photo by Attilio Maranzano)	
13	*The Florence Experiment*, 2018 Analysis Laboratory, Strozzina (Photo by Attilio Maranzano)	
14	*The Florence Experiment, 2018*, Cinema Theatre, Strozzina (Comedies) (Photo by Attilio Maranzano)	
15	*The Florence Experiment, 2018*, Cinema Theatre, Strozzina (Horror films.) (Photo by Attilio Maranzano)	
16	*The Florence Experiment***,** *2018*, Wisteria plant vines growing on Palazzo Strozzi façade (Photo by Attilio Maranzano)	
	PORTRAITS	
17	Carsten Höller. Institute of Phytopathology, University of Kiel, ca. 1988. © Carsten Höller Studio, photographer unknown.	

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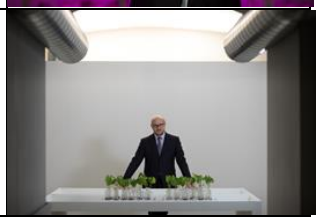
18	Carsten Höller.(Photo by Alessandro Moggi)	
19	Stefano Mancuso, founder of the science of plant neurobiology	
20	Stefano Mancuso with bean seedling	
21	Stefano Mancuso with bean seedling (Photo by Alessandro Moggi)	
22	Fondazione Palazzo Strozzi Director General, Arturo Galansino in the Strozzina analysis laboratory with bean seedling (Photo by Alessandro Moggi)	

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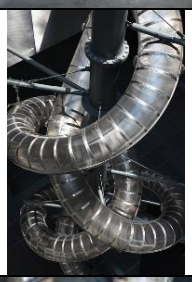
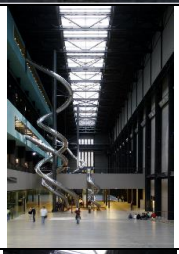
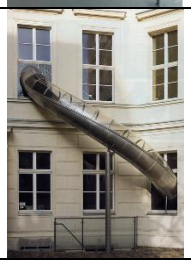
	CARSTEN HÖLLER OTHER WORKS	
23	*Isomeric Slides*, "Decision", Hayward Gallery, London, 2015 (Photo by Attilio Maranzano)	
24	*Victoria Slide*, **"**Experience", New Museum, New York, 2011 (Photo by Benoit Pailley)	
25	*Double Slide*, Museum of Contemporary Art Zagreb, Zagreb, 2009 (Photo by Attilio Maranzano)	
26	*Double Slide*, Museum of Contemporary Art Zagreb, Zagreb, 2009 (Photo by Attilio Maranzano)	
27	*Test Site*, Tate Modern, London, 2006 (Photo by Attilio Maranzano)	
28	*Test Site*, Tate Modern, London, 2006 (Photo by Attilio Maranzano)	

29	*Solandra Greenhouse (Garden Of Love),* "Carnegie International 2004", Carnegie Museum of Art, Pittsburgh, 2004	
30	*Valerio II,* "Kunst-Werke", Berlin, 1998 (Photo by Jens Ziehe)	

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CATALOGUE ESSAYS

The Florence Experiment at Palazzo Strozzi

by Arturo Galansino

The parameters around which this revolutionary project revolves and the horizons within which it moves are already evident from its title. Like so many great scientific experiments, Palazzo Strozzi's new and ambitious incursion into the realm of the contemporary is named after the city in which it has been carried out. Indeed, the project is intended to reinforce a coupling, that between art and science, for which Florence has long been renowned.

Artistic practices in Renaissance Florence evolved out of an alliance with the scientific world of the time, combining different disciplines. In the fifteenth century, it was precisely thanks to the experimental observations of Filippo Brunelleschi, the inventor of linear perspective, that artists were able to achieve the highest and most truthful representation of nature, through a figurative revolution that counts the works of Masaccio as its earliest examples. In the Florentine workshops of the day, a wide range of scientific subjects were taught, including anatomy, which was based on the dissection of corpses, an activity that was considered indispensable for the training of artists. From this eclectic tradition sprang the universal genius of Leonardo da Vinci, who more than any other artist embodied the harmony between art and science, with his exploration of every sphere of knowledge and his conviction that only the artist can unveil and comprehend the natural world. He carried out his investigations in the fields of anatomy and hydraulics, mechanics and geometry, physics and physiognomy, flight, and the military sciences. Even in botany, Leonardo is considered a trailblazer.

At Palazzo Strozzi, for the first time, an innovative science, plant neurobiology, has been paired with the unsettling language of the artist and scientist Carsten Höller, who sets out to challenge people’s relationships with art and museums, assigning visitors an active role and making their reactions an integral part of his work. The scientific validity of this 'artistic experiment' is guaranteed by the prestigious collaboration of Stefano Mancuso, director of the Laboratorio Internazionale di Neurobiologia Vegetale (LINV) at the University of Florence, which carries out research into the intelligence and behaviour of plants, seen as complex beings endowed with extraordinary powers of perception and capable of communicating with their environment through the volatile chemical compounds they are able to detect and emit.

The Florence Experiment proposes a modern reflection on the concept of ecology: not just in the sense that we wish to encourage greater respect for nature, but, more precisely, in the sense that we wish to foster a new awareness of the ways human beings relate to and interact with members of the vegetable kingdom. And by turning one of the most important buildings of the Renaissance into a true laboratory of biological and social experimentation—with notions of consciousness, empathy, sensitivity, and the communicative and emotional capacities of all living creatures—we also aim is to renew the alliance between art and science.

Thanks to the work of Carsten Höller and Stefano Mancuso, Palazzo Strozzi has become the symbolic location of a rediscovered bond between humanity and nature.

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What Is a Plant?

by Stefano Mancuso

Dispersed Organisations

Around 520 million years ago—we have known the precise date for only a few weeks now—plants emerged from the sea onto land [J.L. Morris et al. 2018. 'Timescale of early land plant evolution' (*PNAS*, 2018). DOI: 10.1073/pnas.1719588115], taking the opposite decision to that of animals: they chose (evolutionarily speaking) not to move, obtaining all the energy they needed to survive from the sun, through photosynthesis, and adapting to cope with predation and the innumerable other constraints that derive from sessility. Because they are unable to run away from danger, plants have developed an extraordinary ability, which lacks true parallels among animals, to sense even the smallest change in the environment well in advance, enabling them to modify their anatomy and physiology in time to adjust. Obviously, the sessility of plants has led to the development of very different bodies compared to those of animals. So much so that to us they seem like completely alien beings. Plants have evolved to survive while keeping still. Try to picture how difficult it is to survive in a hostile environment without being able to move. Imagine being a plant, surrounded by predators of every kind. The only way to stay alive is to have a totally different structure from that of an animal. To be a plant, in other words. To cope with the problems that arise from predation, plants have taken a unique and distinctive path in their evolution, coming up with solutions so different from those of animals that they have truly become an example of otherness for us. Many of the solutions devised by plants are the complete opposite to those devised within the animal kingdom. As if in a photographic negative, what is white in animals is black in plants, and vice versa: animals move around, plants are sessile; animals are fast, plants slow; animals are heterotrophic, plants autotrophic; animals give off CO_2, plants fix CO_2; and so on. The list of anatomical and physiological opposites between plants and animals carries on all the way to the one that I consider the most decisive, but also the least familiar by far: the contrast between dispersion and concentration. We could sum it up as follows: all the functions that in animals are concentrated in specialised organs are dispersed throughout the organism in plants. It is a difference so fundamental that it is hard to appreciate its consequences. In fact, it changes everything. This difference in their organisation is one of the reasons why plants appear so distant and alien. The fact that, like us, other animals have a brain, a heart, a mouth, lungs, and a stomach makes them close and comprehensible; the same cannot be said of plants. But why have plants not developed the specialised organs that have proved so useful in the animal world? The reason is that single or dual organs are *weak points*. Let's imagine a plant equipped with lungs, or a stomach, or a brain, or eyes. As soon as the first little animal comes along to eat even a small portion of these organs—no need to picture a large herbivore, even a caterpillar would suffice—the plant would die. Every structure in which single or dual organs are essential to survival is inherently fragile—a universal rule that holds as much for living creatures as it does for any other kind of organisation. Think, for example, of the extreme fragility of our body. All it takes is the banal malfunctioning of any one of our single or dual organs for our survival to be threatened. It is one of the consequences of our animal organisation; not the only one, and perhaps not even the most important one. Having a brain that presides over the functions of the various specialised organs has influenced every type of organisation or structure that humanity has ever conceived. We replicate our centralised organisation everywhere. Our society, companies, offices, schools, armies, associations, political parties, all are organized as pyramidal structures. The instruments we use, even the most modern ones, are simple synthetic equivalents of ourselves: computers, for example, have a processor that mimics the functions of our brain and cards and boards that imitate the functions of our organs [S. Mancuso S. *Plant Revolution* (Florence: Giunti Editore, 2018)]. The extraordinary nature of plant organisation lies in its being a dispersed—and therefore far more robust—alternative, to the animal model. Even lacking specialised organs, plants are perfectly capable of performing many of the functions that we as animals associate with specific organs. The plant breathes without lungs, feeds without a mouth, digests without a stomach, sees without eyes, hears without ears, and, finally, decides, communicates, competes, cooperates, and solves

problems without a brain. It is even able to remember and learn from experience. All this without a brain, or any similar structures to which such tasks can be assigned. Plants, in other words, do not have a centralised organisation; everything in them is dispersed and not allotted to specific organs. A modular structure, not a pyramidal one. In a way, the plant behaves as if it were a colony. It is not the individual ant, but the whole colony that best represents the way in which plants are structured and operate. The similarity is so great that the structure of the root system, the way in which it explores the soil and utilises its resources, has recently been described using swarm behaviour as a model, as one would in the study of insects.

From the viewpoint of structure, functionality, and resistance, plants are undoubtedly more modern organisms than animals. In a sense, the way they are constructed is the quintessence of modernity: a modular, cooperative and distributed architecture without command centres, able to cope perfectly with catastrophic and repeated predation without loss of functionality. Plants, if you think about it, ought not even to be defined as individuals. Indeed, the word 'individual' (from the Latin *individuus*, a word made up of the privative prefix *in* and *dividuus*, 'divided') literally means 'indivisible'. Now, if an animal, with very few exceptions, is essentially indivisible—if you cut it in half, it dies—plants are so easy to divide that their successive subdivision is used as a method of propagation. Every human creation that we consider truly modern, from the internet to Wikipedia, from cryptocurrencies to the blockchain, responds to the same requirements of robustness, dispersion and decentralization that plants have dealt with over the course of their evolution.

The Intelligence of Plants

Plant intelligence seems at first sight to be a perfect example of an oxymoron. In our language as in many others, one is *reduced* to a vegetative state when one no longer has any awareness. The vegetative state is a clinical condition characterised by the presence of waking activity in the absence of any consciousness of one's self or of one's surroundings [F. Ferrarelli. 'Stato vegetativo', in *Enciclopedia della Scienza e della Tecnica* (Rome: Treccani, Istituto dell'Enciclopedia Italiana, 2008)]. A definition that recalls Buffon's description of the plant as 'a sleeping animal'[G.L.L. Buffon, 'Dissertation on the Nature of Animals', in id., *A Natural History, General and Particular*, trans. W. Smellie. (London: Richard Evans, 1817)]. To speak of plant intelligence, then, would appear to be a contradiction. But is that the case? Obviously not, and, in what follows, I hope to be able to show you that the idea that plants are not capable of doing anything, let alone sensing things, is completely unfounded, and the fruit of an unpardonable superficiality. In the first place, where does this bizarre idea that plants are not able to perceive their environment come from? The origin of the error is an ancient one, and we owe it to Aristotle, who in his *De Plantis* (whose title is in Latin because the Greek original has been lost), expresses his disagreement with Plato, declaring:

> The view of Plato, then, who held that plants have sensation and desire was remarkable, but not unsound; but Anaxagoras and Democritus and Empedocles declared that they possessed intellect and intelligence. These views we must repudiate as unsound and pursue a sane statement of the case. I assert, then that plants have neither sensation nor desire; for desire can only proceed from sensation, and the end proposed by our volition changes in accordance with sensation. In plants we do not find sensation nor any organ of sensation, nor any semblance of it, nor any definite form or capacity to pursue objects, nor movement or means of approach to any object perceived, nor any sign whereby we may judge that they possess sense-perception corresponding to the signs by which we know that they receive nutriment and grow [Aristotle, 'On Plants', trans. E.S. Forster, in id., Complete Works of Aristotle, Volume 2: The Revised Oxford Translation, ed. John Barnes (Princeton: Princeton University Press, 1984), p. 1251].

For Aristotle, then, plants lack perception, organs of sensation, and movement (all erroneous claims). However, according to the philosopher, the real problem, lay in the fact that they do not possess the capacity for perception, This is the crucial factor that differentiates them from animals, rendering them inferior:

> sensation is common to all animal life [...]: the inanimate is that which has no soul or any portion of it. But a plant is not one of those things which entirely lack a soul, because there is some portion of a soul in it; and it is not an animal, because there is no sensation in it [...] [Ibid., p. 1253.].

Aristotle's influence on botany as well as on other scientific subjects lasted for an unimaginably long time, at least up until the Enlightenment, for a period of about two thousand years. He left a very resilient idea behind, one that has proved difficult to shake off, that plants are passive beings and, in any case, inferior to animals. Even today, our understanding of plants is vague, and associated with a mistaken belief in their marked inferiority with respect to the animal kingdom. In 1880, the already elderly Charles Darwin, in collaboration with his son Francis, published *The Power of Movements in Plants*. It was Darwin's sixth book on plants. The five preceding books—*On the Various Contrivances by Which British and Foreign Orchids are Fertilised by Insects: And on the Good Effect of Intercrossing* (1862), *The Movements and Habits of Climbing Plants* (1865), *Insectivorous Plants* (1875), *The Effects of Cross and Self Fertilisation in the Vegetable Kingdom* (1876), and *The Different Forms of Flowers on Plants of the Same Species* (1877)—represent a detailed summary of Charles Darwin's eclectic botanical work. They are, in addition, crammed with original observations, from which the author drew when writing his celebrated *On the Origin of the Species*. Of these six books, the final one, *The Power of Movement in Plants*, was the one that had the longest and most arduous gestation, not only because of the importance and delicacy of the subject, but also because it came into existence following a family tragedy. Indeed, following this tragedy, Darwin had not intended to carry on writing. In 1877, he had declared, 'I do not suppose I shall publish any more books [...]. I cannot endure being idle, but heaven knows whether I am capable of any more good works'. This is because, in 1876, Francis Darwin's young wife, Amy, had died while giving birth to 'baby' Bernard. Both Francis and Charles, for whom the death of Amy was a painful reminder of the loss of Charles's beloved daughter Annie, fell into a state of deep depression that would last for a long time, and from which both eventually emerged in the only way they knew, by working day and night on a new project: the study of the movement of plants. This collaboration between father and son was extremely fruitful. Charles was familiar with everything that had been written on botany, while Francis introduced his father, an acute observer of nature but hardly an experimenter, to the advantages of experimental botany. The result was one of the first proper plant physiology books, as well as a unique and exceptional lab diary, which anyone who engages in research activity, not just in the botanical field, ought to read, in order to learn the rudiments of scientific practice. Leaving aside the fact that this was the first book to examine the numerous and complex movements made by plants, *The Power of Movement in Plants* is also a milestone in the history of botany because of Charles and Francis Darwin's suggestion that the root tips of plants are the location of a peculiar form of vegetable 'brain'. On the last page of the last chapter of their book, the Darwins reflect on the sensitivity displayed by the root tip: 'it is hardly an exaggeration to say that the tip [...] acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense organs, and directing the several movements' [Charles and Francis Darwin, *The Movements of Plants* (London: John Murray, 1880)]. They are clear about the implications of this statement. They do not use the word 'brain' as a metaphor for something else, nor is their use of the word tongue-in-cheek, as has been suggested. Charles Darwin considered the 'root-tip brain' a serious postulate. In his autobiography (published posthumously in 1888) he wrote that he 'felt an especial pleasure in showing how many and what admirably well adapted movements the tip of a root possesses'[Francis Darwin (ed.), *The Life and Letters of Charles Darwin, including an Autobiographical Chapter* (London: John Murray, 1887)]. In addition, in a letter written on November 23, 1880, to Sir Joseph Hooker, president of the Royal Society, Darwin sought to attract the attention of his friend to his new book by writing that '[t]he case, however, of radicles bending after exposure for an hour to geotropism, with their tips (or brains) cut off is, worth your reading [...]; it astounded me'. Charles Darwin was no amateur; he understood the physiology of plants well. He was, first of all, a botanist, indeed the greatest of his time. In a letter, again to Sir Joseph Hooker, he wrote that he found 'any proposition more easily tested in botanical works [...] than in zoological works'. Botany was a Darwin family tradition: Charles's grandfather Erasmus was an influential botanist; Charles's son Francis would hold one of the first chairs of plant physiology, at Cambridge. In short, it could be said that the story of the Darwin family and

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the history of botany over the last two centuries are inextricably entwined. So anything that Charles Darwin wrote about plants is worthy of our full attention. Including, obviously, his claims about the root apex, which he called the 'brain' of the plant. If we carefully examine the last sentence of his book on the movement of plants, we become aware of another astonishing claim on Darwin's part: he writes 'the brain being seated within the anterior end of the body', meaning by this that the anterior part of the plant should be considered the root tip (the seat of its cognitive activity). It follows that the posterior part of the body is the foliage, seat of the reproductive organs (flowers). Thus the Darwins compared the general design of the body of a plant to that of an animal, in which the sentient and reproductive poles represented, respectively, the anterior and posterior parts of the body.

At the end of his long career, the greatest biologist in history would write: 'It always pleased me to exalt plants in the scale of organised beings'. And the whole of his activity as a botanist bears witness to this predilection. In Darwin's work, the effort to describe plants as complex living creatures, not inferior to animals but simply different, is evident. Today, we know that the root tip is able to sense and react to more than twenty different environmental parameters, [A.J. Trewavas, *Plant Behaviour and Intelligence* (Oxford: Oxford University Press, 2014)], including light, gravity, humidity, temperature, mineral content, and the mechanical resistance of the soil, discriminating between them and deciding which are the most important for the survival of the plant [S. Mancuso and A. Viola. *Verde Brillante*. (Florence: Giunti Editore, 2013). English ed. *Brilliant Green*, trans. J. Benham (Washington, DC: Island Press, 2015)]. In addition, a study carried out in my laboratory has shown that the apex of the root is the location of an intense and coordinated exchange of electrical signals between the cells of which it is made up, whose appearance and behaviour bear a close resemblance to electrical activity in the neurons [E. Masi et al., 'Spatio-temporal dynamics of the electrical network activity in the root apex' (*PNAS* 106, 2009), pp. 4048-53]. If we consider the roots to be one of the seats of the activity of sensation and calculation, our vision of the plant is very different from the one most commonly held. The roots become the plant's most important organ, their tips forming a front that is continually advancing and that has innumerable command centers. The root system as a whole guides the plant with a sort of dispersed brain—or, rather, intelligence—distributed over a wide area, which acquires information important for the survival of the plant while it grows and expands. This advancing front can reach astounding dimensions. A single rye plant, for example, can rely on tens of millions of root apices [H.J. Dittmer. 'A quantitative study of the roots and root hairs of a winter rye plant (*Secale cereale*)' (American Journal of Botany 24, 1937), pp. 417-20], and this is a very small number indeed compared to the production of root tips by a fully grown tree. It is not easy to obtain reliable figures, but over a thousand such tips have been counted in a single cubic centimetre of forest soil [W.H. Lyford, 'Rhyzography of non-woody roots of trees in the forest floor', in J.G. Torrey and D.T. Clarkson (eds.),.*The Development and Functions of Roots* (London: Academic Press, 1973), pp. 179-96].

But let us go back now to the concept of intelligence, and ask whether it is legitimate to talk of it in connection with organisms, like plants, that do not possess a brain. While no one would ever dream of denying that a plant feeds or breathes even though it has no digestive system or lungs, mere mention of the idea that plants might be intelligent without having a brain generally provokes a negative reaction. And yet we have already seen that, for plants, it is *necessary not to possess a brain*, or any other single or dual organ. In plants, intelligence, like every other function that in animals is concentrated in specialised organs, is spread throughout the entire body. It is not the presence or absence of a brain that determines whether an organism is intelligent or not. So what does? Let's start by defining the concept of intelligence. Although hundreds of different definitions of the concept exist (it has been joked that there are as many definitions of intelligence as there are researchers who have been asked to define it), I have a clear opinion on the matter: *intelligence is the ability to solve problems*. If we use this definition, plants are unquestionably intelligent beings. Indeed, the way in which they solve their problems could be an invaluable source of ideas for us. So where does the problem lie? In the definition, obviously. The majority of definitions of intelligence tend to limit this faculty to the human species, extending it at most to the animals that are most closely related to us. It is as if humanity were afraid of losing its special position in the universe. I have never found this convincing. For me, intelligence is a property of life; something that even the most humble single-celled

organism must possess: it too, like us, has to continually solve problems. Without intelligence there can be no life. That's how I see it. Of course, the intelligence of a human being is orders of magnitude greater than that of a bacterium or a unicellular alga but the difference is only quantitative, not qualitative. Otherwise, at what point in evolution did intelligence first appear? Humans are intelligent. Primates? Intelligent. Dogs? Intelligent. Cats? Also. And rats? Aren't they intelligent? And octopuses? Reptiles? Insects? And the amebae that are able to find their way out of a maze or anticipate repetitive phenomena? [T. Saigusa et al., 'Amoebae anticipate periodic events' (*Physical Review Letters* 100: 2008), 018101]. In short, is there a threshold at which intelligence magically appears, or, more sensibly and, from an evolutionary perspective, more correctly, should we see intelligence as something that is inherent in life? If this is not the case, then where are we going to place the threshold at which intelligence appears? Is it a fixed threshold or a cultural one that varies with time and place? In the nineteenth century, no one thought that an animal could be called intelligent, whereas today none but a few fanatics would say that an ape or a dog or even a bird are not. There is even an extensive literature on the subject of bacterial intelligence. So why not speak of the intelligence of plants as well? It might be argued that the behaviour of plants *seems* intelligent but that in reality plants have no choice in what they do, as they are limited to automatic responses dictated by genes, instinct, or the environment, or other such puppet masters. As has already been pointed out, plants respond to numerous environmental stimuli, such as sources of energy (light, minerals, and water), mechanical stresses, the structure of the soil, humidity, temperature, and the proportions of gases in the atmosphere. In each case, the force, direction, duration, intensity, and specific characteristics of the stimulus are individually distinguished by the plant. Biotic signals like the presence or absence of other plants in the vicinity and the identity of these plants, as well as competition, predation, and disease, are other stimuli, often of an extremely complex nature, that the plant picks up continually, and which it responds to in an appropriate manner. Given the enormous number of signals that a plant has to integrate in a single response, an automatic reaction cannot be sufficient. There is not a single separate response for each of these signals, but a response that arises from the combination of all these parameters perceived simultaneously and integrated with information on the internal state of the plant. In these cases, only a complex calculation can provide the responses needed for survival. Not a month passes without the discovery of new and surprising patterns of plant behaviour. Many of these are so complex that they cannot be adequately described without resorting to the term intelligence.

A CLOSER LOOK

THE FLORENCE EXPERIMENT IN NUMBERS

Structure type: 2 intertwined slides
Material: Steel + polycarbonate
Diameter: Ø 80 cm
Height from the loggiato: around 20 m
Length: around 50 m each
Declivity: 28°
Number of bolts: 265
Number of nuts: 265
Number of washer: 552
Structure weight: each slide weights around 3600 kg; the whole structure (slides + metallic structure) weights around 12,5 tonnes
Fall speed: 7 meters/sec .highest value; 4-5 meters/ sec. average value
Fall timing: 15 sec**.**
How many people per minute can fall: about 90-120 Person per hour
How many belts-containers for bean seedlings: 100
How many sliding bags: 200
How many metallic baskets for sliding bags: 6

STROZZINA: 2 equipped hall-box of the CINEMA experiment with 15 chairs each**;** 2 air intake hoods and conduction pipes

ANALYSIS LABORATORY: 2 sinks**;** 1 LI-6800F Portable system for measuring photosynthesis and fluorescence; 1 microscope; 2 equipped counters;1 fridge; Glassware: 4 cylinders, 8 glasses, 4 flasks, 200 petri dishes, 1 dryer, 4 flasks, 4 flasks; 4 balloons; 2 funnels; 10.000 syringes; 10 metal trays; 10 coats; 2 coat rack; 2 whiteboard with felt-tip pens; 2 digital clock; 2 tables for delivery of the plants

APPLIANCES USED: LI-6800F Portable Phosynthesis System (LI-COR Biosciences); PTR-TOF 8000 System for real-time trace gas analysis of VOCs (Ionicon)

GROWROOM: 10.000 bean seedlings in biodegradable jars**;** 10.000 sterile bags**;** 3 shelves with plants growth banks (each contains 400 jars); 2 moving shelves

PLANT DELIVERY ROOM: 4 tables with bean seedlings already analysed

POSTER SESSION: 12 scientific posters

FACADE: 8 Glycine plants (Wisteria sinensis Alba); 8 iron vases and 16 steel cables for climbing plants**;** 1 irrigation system**;** 2 air pipes from the Strozzina with 16 smaller tubes

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CARSTEN HÖLLER | BIOGRAPHY

Carsten Höller uses his training as a scientist in his work as an artist, concentrating particularly on the nature of human relationships. Born in Brussels in 1961, he now lives and works in Stockholm, Sweden and Biriwa, Ghana. His major installations include *Test Site*, a series of giant slides for Tate Modern's Turbine Hall (2006), *Amusement Park* - an installation of full-size funfair rides turning and moving at very slow speed at MASS MoCA, North Adams, USA (2006), *Flying Machine* (1996), a work which hoists the viewer through the air, *Upside-Down Goggles*, an experiment with goggles which modify vision, and the famous *The Double Club* (2008-2009) in London, which opened in November 2008 and closed in July 2009, took the form of a bar, restaurant and nightclub designed to create a dialogue between Congolese and Western culture. His *Revolving Hotel Room*, 2008, a rotating art installation that becomes a fully operational hotel room at night, was shown as part of *theanyspacewhatever* exhibition at the Guggenheim Museum in 2009. For his 2015 exhibition *Decision* at the Hayward Gallery, he turned the whole building into an experimental parcours with two entrances and four exits, two of them slides. His works have been shown internationally over the last two decades, including solo exhibitions at Fondazione Prada, Milan (2000), the ICA Boston (2003), Musée d'Art Contemporain, Marseille (2004), Kunsthaus Bregenz, Austria (2008), Museum Boijmans Van Beuningen, Rotterdam (2010), Hamburger Bahnhof, Museum für Gegenwart, Berlin (2011), New Museum, New York (2011) Thyssen-Bornemisza Art Contemporary (TBA21), Vienna (2014), Pirelli HangarBicocca, Milan (2016), Henie Onstad Kunstsenter, Høvikodden, Norway (2017).

STEFANO MANCUSO | BIOGRAPHY

Stefano Mancuso is the founder of the science of plant neurobiology. A tenured professor at the Università di Firenze and a tenured academician at the Accademia dei Georgofili, he directs the International Laboratory of Plant Neurobiology (LINV, www.linv.org) with offices in Florence, Kitakyushu, Bonn and Paris. He is a founder member of the International Society for Plant Signaling & Behavior. He is a Fellow Professor at numerous international universities. He is also the founder and editor-in-chief of the periodicals *Plant Signaling and Behavior* (USA) and *Advances in Horticultural Science*. In 2010 he was the first Italian scientist ever to be invited to speak at a TED GLOBAL. In 2013 he published his prizewinning best-seller *Brilliant Green* which has been translated into twenty-one languages so far. In 2016 he was the first non-German speaking author to win the Austrian Ministry of Science and Technology's "Wissenschaftbuck des Jahres" prize for the best scientific essay. In 2014 he founded PNAT (www.pnat.net), a start-up with the Università di Firenze for the creation of technology inspired by plants. With PNAT he produced the Jellyfish Barge, an independent, totally eco sustainable floating greenhouse which he presented at Expò 2015 in Milan and with which he has won numerous international awards. The *New Yorker* has added his name to its list of "world changers" and *La Repubblica* lists him as one of the twenty Italians "fated to change our lives". He has written numerous books and contributed scientific essays to over three hundred international journals. In 2016 and 2017 he was invited by the President of the Chilean Republic to attend the *Congreso del futuro* hosted by the Senate of the Republic of Chile. He has been the Chilean Government's advisor on innovation issues since 2016. He has recently published, with publishing house Giunti, *Plant Revolution*, *Men Who Love Plants* and *Biodiverse* (written jointly with Carlo Petrini). Working in conjunction with the Deproducer, he has devised a theatrical musical performance entitled *Botanica*.

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