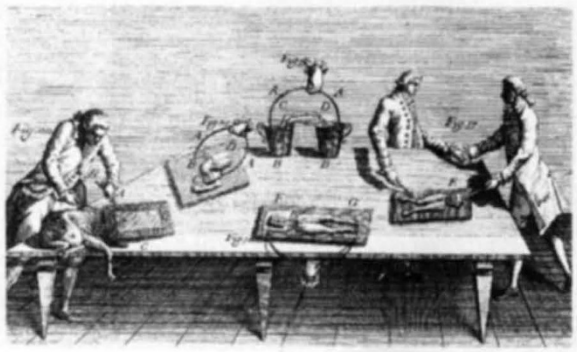
Spark gaps

Willem D. Hackmann

The Ambiguous Frog: The Galvani–Volta Controversy on Animal Electricity. By Marcello Pera, translated by J. Mandelbaum. *Princeton University Press: 1991. Pp. 203. $29.95, £18.*

IN 1745, fellows of the Royal Society of London were astonished to learn about a novel experiment performed at Leipzig in which sparks were drawn from the lips of an electrified woman by anyone who tried to kiss her. They immediately set about acquiring the electrostatic generator used to produce this 'electric kiss', in no doubt that when the apparatus arrived in London "our own Country-Women will be found to have as much Fire in their Lips as any of their Sex in *Germany*". During the next decade, the human body formed an integral part of the electrical machine, acting as a collector of charge when suspended by silk cords or insulated by a cake of wax. The physiological reactions to electric shock were obvious and there was much debate about the seat of electricity in the body. Early conjectures compared the brain to the electrostatic generator, and the nerves to the conductors or wires through which electricity and volition were transmitted. Others assumed that electricity in animals was produced by ingested food or the friction caused by the circulation of the blood. New impetus was given to these ideas by the discovery of the electric organs of the torpedo fish and, in 1781, by Galvani's chance discovery of the sudden twitching of dissected frog legs when an electrical machine was discharged nearby.



Animal electricity — from Galvani's *Commentarius* of 1791.

In a series of carefully executed experiments, Galvani found that he could produce the same spasmodic convulsions when the frog formed part of a circuit containing one or more pieces of metal, and in 1791 he not unnaturally postulated the existence of animal electricity as distinct from the common variety studied in the laboratory. He suggested that the muscle fibre and the enclosed nerve acted in the manner of a Leyden jar (a primitive capacitor). The storm Galvani provoked among physicists, physiologists and physicians can be compared with the political storm that arose at that time over Europe. Volta disagreed profoundly with Galvani's ideas, suggesting instead that electricity was simply an agent of nervous stimulation.

The Ambiguous Frog is not, as Bernard Cohen makes clear in the foreword, a conventional recasting of a familiar story. Instead, Professor Pera introduces the Galvani–Volta controversy as a fable of how a dissected frog when requested to reveal its inherent electricity made a mockery of a doctor and a physicist, and revealed their hidden metaphysics instead. What Pera brings out of this scientific fable very clearly and cleverly is that we have here a conflict not just of two different research programmes but of two different gestalten in the same area of observations: the electrobiological gestalt of Galvani, the anatomist, versus the electrophysical gestalt of Volta, the physicist.

Both scientists performed crucial experiments that validated their own theoretical framework. Galvani proposed a naturally unbalanced animal electricity, Volta an artificially unbalanced electricity in animals. This induced Volta to develop his special contact theory of electricity of metals into a general theory of contact electricity in which all conductors, metallic or not, are electromotive. His general theory of contact electricity had two important consequences: first, it stated the same thing as Galvani's animal-electricity theory but with a different interpretation about the realm to which the phenomena belonged; second, it resulted in 1800 in his momentous discovery of the voltaic pile, the first electrochemical battery, the harbinger of profound conceptual and technological advances in physics. Because of the theoretical positions they had taken up, Galvani never explored the possibility of the existence of the "current of injury" in these phenomena, and Volta failed to see the importance of the chemical effect in the action of his pile.

The key point of Pera's scientific fable is that scientific controversies are not usually won on facts alone, despite what Volta himself wrote on the subject. The protagonists each have their own 'interpretative theories' that specify the phenomena as they see them. In this case, because neither Galvani nor Volta accepted his adversary's gestalt, there could be no genuine crucial experiment to decide between the competing theories. Pera likens this situation to the interpretation of ambiguous shapes, such as Joseph Jastrow's duck–rabbit, in which the same perceptive material is self-organized into different forms, the one that is seen depending on the gestalt adopted by the observer. In the case of the frog leg, do we see an organic capacitor or a physical electromotor? As Pera points out, although in these scientific episodes we go beyond the language of facts and inductive logic, we can still conduct a rational discussion. □

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What ghost in the machine?

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Consciousness Explained. By Daniel C. Dennett. *Little, Brown: 1991. Pp. 511. $27.95. To be published in the United Kingdom by Allen Lane The Penguin Press on 16 March at £20.*

TWENTY years ago, scientists rarely referred publicly to consciousness. Today the taboo has been lifted. Cognitive scientists and neuropsychologists now describe many phenomena involving awareness and speculate widely about consciousness, although this newly found confidence has not been matched by much gain in theoretical understanding.

Philosophers of mind have responded in two different ways. Some have built Chinese walls to keep their territory inviolate from the crudely functionalist cognitive scientists. But others, above all Dan Dennett, have responded positively and attempted to adapt their theorizing to developments in cognitive science and neuroscience. Over the past 20 years, Dennett has written three important works on consciousness — *Content and Consciousness* (1969), *Brainstorms* (1978) and now, most grandly of all, *Consciousness Explained*. The first book, apart from taking the functionalist approach, shows little direct scientific influence. *Consciousness Explained*, by contrast, is full of fascinating accounts of scientific findings. The philosophical ideas it contains are influenced by a range of disciplines from evolutionary theory through neurophysiology and cognitive psychology to artificial intelligence. This, then, is a book to which scientists interested in the philosophy of mind will naturally warm.

"What we have to understand", Den-