in its tracks. Reardon sees little to celebrate in this victory. The project's proponents correctly predicted from the start that, if they failed, the research would continue but in a much less public and organized way. The study of human genetic variation is now fashionable, but it is being pursued without scrutiny of the deeper issues that Reardon believes essential to the pursuit of both a more reflective science and a more sensitive society. Funders have understandably tried to avoid the controversies that sank the Diversity Project. But the ironic result has been to narrow discussion of the issues at stake even further. ■

Diane Paul is in the Department of Political Science, University of Massachusetts, 100 Morrissey Boulevard, Boston, Massachusetts 02125-3393, USA.

Touching a nerve

The War of the Soups and the Sparks: The Discovery of Neurotransmitters and the Dispute over How Nerves Communicate
by Elliot S. Valenstein
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Charles Stevens

Controversy is an inevitable, and essential, part of science, but one that scientists generally find uncomfortable and tend to regard as a blemish to be hidden from the public. Elliot Valenstein's book *The War of the Soups and the Sparks* is a readable and instructive history of one of neuroscience's most important scientific disputes, the three-decade debate about how neurons communicate with one another. He explains the way our current views developed and places the work in its social and human context by providing biographical sketches that bring the participants to life.

One neuron sends information to another at a point of contact known as a synapse. We now understand this process of information transfer in great detail, and know that it involves the release of a chemical, called a neurotransmitter. Valenstein's book is about how we arrived at this picture, and especially about the controversies along the way. The main debate related to whether synaptic transmission is chemical — that is, whether the information-carrying signal is the release of a neurotransmitter — or whether it, like the nerve impulse itself, uses purely electrical signals.

The story begins about a hundred years ago with investigations of how nerves influence the function of organs; an example is the slower heart beat produced by stimulating the vagus nerve. By 1920 it was firmly established, largely by Henry Dale, that acetylcholine, a chemical not known at the time to occur in the body, also decreased the heart rate and duplicated various effects of nerve stimulation on other organs. But the idea that the vagus nerve secreted acetylcholine or something similar was not considered: nerves are tiny, seemingly too small to be the source of hormone-like chemicals.

Starting in 1921, Otto Loewi published a series of papers claiming that the vagus nerve secretes some chemical — he called it *Vagusstoff* — when stimulated, which slows the heart. Loewi's work met with great scepticism, partly because he could not show that the *Vagusstoff* came from the vagus nerve and not the heart, but mainly because others could not repeat his technically tricky experiments. Using improved techniques, Dale identified the *Vagusstoff* as acetylcholine and showed that it was released by the stimulation of many different nerves that affect the function of various organs. By 1936 the conclusion that neurotransmitter is released at synapses outside the brain was well enough established to attract a Nobel Prize for Loewi and Dale.

In 1936, physiologists could accept that the neurotransmitter released by the vagus nerve slows the heart and has other slowly developing effects. But they could not believe that this mechanism could cause rapid events such as the contraction of skeletal muscle or communication in brain circuits. Instead, they were convinced that this must be due to a direct spread of current from nerve impulses, known to involve electrical rather than chemical signals.

Almost all neurophysiologists believed that synaptic transmission had to be electrical, rather than chemical. One of the most prominent opponents of chemical transmission for fast synapses was John Eccles, a friend and great admirer of Dale. Their debate was vigorous, but good-natured and respectful. Valenstein points out that the physiologists believed that only electrical transmission could be fast enough, but also that the dispute was a class war between pharmacology and physiology. The physiologists used modern, sophisticated methodology and tools, such as the cathode-ray oscilloscope, whereas pharmacologists were still using bioassays, such as leech muscle, and old-fashioned recording methods. The physiologists looked down on the pharmacologists, and felt that conclusions based on methods less sophisticated than their own were not to be trusted.

This dispute continued until the middle of the twentieth century, when results from new technology finally convinced the physiologists that synapses do communicate by the release of neurotransmitters. Eccles, one of the strongest proponents of electrical transmission at synapses, provided some of the key evidence showing that he, and the other physiologists, had been wrong.

Why did this argument last so long? As with all such disputes, part of the reason was that technology was not available that could provide decisive tests of the alternative possibilities; the correct answer came with technological advances. The other reason is that synaptic transmission is much more complex than either side envisaged, and the discussion was framed in simplistic terms because the scientists involved sought simplicity where it did not exist. ■

Charles Stevens is at the Salk Institute for Biological Studies, PO Box 85800, San Diego, California 92186-5800, USA.

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A stimulating debate: Henry Dale (top) and Otto Loewi showed that nerves release chemicals.

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