REVIEWS OF SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

Victor D. Chase, *Shattered Nerves: How Science is Solving Modern Medicine's Most Perplexing Problem*, (Johns Hopkins, Baltimore, 2006), 289 + xiii pp., ISBN 0-8018-8514-0, $27.50.

The miniaturization of integrated circuitry has enabled development of neural prostheses which can be implanted in the human body to restore the ability of the brain to receive perceptory input or transmit motor output, and it is these neural prostheses that form the subject of Chase's book. Chase begins with the first commercial neural prosthesis, cochlear implants, which gave Michael Pierschalla a way of "Learning to Listen All Over Again," and then, after two chapters of tracing the history of developments in electricity and electronics which made neural prostheses possible, continues with prostheses to restore lost bodily functions to paraplegics (ranging from bladder and bowel control to the use of their extremities) and sight to the blind.

Key to all these neural prostheses is the interface between the electric circuits that comprise the prostheses and the elements of the nervous system to which they are connected. Chase writes of "the battle between electrons and ions when electricity is introduced into the body via metallic electrodes," a battle that arises because "the entity that carries an electrical charge in metal -- the electron -- is different from the charge carrier in biological tissue -- the ion." Moreover, "electrons do not pass through solutions . . . and ions do not flow through metal." (pp. 188-189) The difference between charge carrier leads to an electrochemical reaction at the interface between metal and nerve. Moreover, one might add, there is a difference in means of information transmission: the nerve functions more like a coaxial cable, generating voltage signals between its outside and inside, rather than as a wire conducting electric current. Put another way, the nerve sends information more in the form of a wave, while electric circuits send it more in the form of a particle. Given this mismatch between human-made systems and humans, it's quite miraculous that neural prostheses work at all, and those who have developed them express even greater hope for the future.

Those who have developed neural prostheses fall into two groups – the biomedical engineers and doctors who developed the actual systems and those who insisted on taking whatever risks were necessary to be outfitted with them in hopes of restoring bodily functions lost by either disease or physical injury. The former group includes Giles Brindley, Terry Hambrecht, J. Thomas Mortimer, P. Hunter Peckham, E. Byron Marsolais, Ronald Triolo, Graham Creasey, Mark Humayun, Eugene deJuan, Robert Greenberg, Alan and Vincent Chow, Richard Normann, Gerald Loeb, Joseph Schulman, John Donoghue, Philip Kennedy, Richard Andersen, Jonathan Wolpaw, and Theodore Berger. In addition to Pierschalla, the latter group includes Jim Jatich, Jennifer French, Holly Koester, Marilyn Davidson, Molly Brown, Harold Churchey, Connie Schoeman, Ronnie Rainge, Maria Zaccaro, and Scott Hamel. These are the heroes of this book, written at a time that an article about the Intel Competition in the 7 March 2007 issue of *The New*

York Times laments that "colleges are no longer producing as many graduates willing to make the financial sacrifices of lives in science," and to do the research necessary to write this book, Chase went out to visit and interview them.

Five days after the article about the Intel Competition, *The New York Times* ran a story on troops returning from Iraq with severe brain injury. "There is no prosthetic for the brain," one advocate for the brain-injured is quoted as saying. Yet even here Chase has something to write about, in a chapter titled "A Hole in the Center of the Brain," which describes development of a chip to convert the output signal from a neuron on one side of a hole in the brain to the input signal to a neuron on the other side of the hole.

Finally, Chase considers the ethical ramifications of what he has written. In his introduction he had already acknowledged that prostheses could also enable the brain to receive input from and transmit output to an external device, thus extending the range of direct human experience if the external device were emplaced far away (albeit with a time lag). This, plus using prostheses to expand the spectrum of sight or hearing, could not only restore bodily functions to those who had lost them but also enhance the bodily functions of already "normal" people. How is this issue related to that of performance-enhancing drugs, and to what extent could it widen the gap between the haves and the have nots?

The more I got into this book, the more I wanted see pictures of what was being described and of the people doing it, and eventually I realized that what I really wanted was to see this program transposed into a *NOVA*-type documentary. The content of Chase's video interviews with the researchers and patients could be interspersed throughout the documentary as it is throughout his book. Then, only two days before finishing this book, I saw a portion of a documentary on television based on a book which, as I found in my local library, like Chase's, has no pictures or diagrams in it. Aha, I thought, there is precedent for my suggestion that Chase's book be made into a documentary. I really hope it is.

- John L. Roeder

(Editor's Note: Vic Chase will be speaking about his book to the Physics and Chemistry Teachers Clubs of New York at Room 207, Silver Hall, New York University, at 7:15 p.m., Friday, 28 September 2007. All are invited, and there is no charge.)