EDITORIAL

Frontiers in Neuroscience

The brain is an organ of the body. This fact is obvious to a scientist and anathema to many lay people. As an organ perfected over years of evolution, the brain performs its functions admirably. As is true of other organs, however, the brain can go wrong if one of its parts is not made correctly. When the brain malfunctions, some nonscientists tend to ascribe the cause to bad parenting, a poor environment, or evil spirits, whereas a scientist tends to ascribe it to a malfunction in the chemistry of the brain. To the lay person the brain may be so lofty in purpose and so complex in structure that the concept that it is "merely chemistry" is unthinkable, and the idea that it cannot be mended by loving care, unacceptable. Neuroscientists, however, know that a brain affected by a mutated gene may be as unfixable with loving care as a watch with a broken mainspring. Of course, the well-informed nonscientist and the well-informed scientist—as well as the well-informed watchmaker—know that both nature and nurture contribute to the functioning of their complex structures.

Understanding the brain is such a difficult enterprise that it must be tackled by an enormous range of theories and techniques. In this issue of *Science*, skillfully organized by Katrina L. Kelner and Gilbert J. Chin, some of the powerful new approaches and experimental tools are reported. Martin C. Raff *et al.* describe principles that control the development of sympathetic and sensory neurons and that also apply to certain glial cells in the brain and to nonneural cells in other parts of the body. An article by Richard M. Harland and coworkers provides evidence that the embryonic protein noggin has the appropriate characteristics to be a true neural inducer, and Marcia Barinaga discusses the implications of this finding in Research News. Joseph T. Coyle and Pamela Puttfarcken show how free radical chemistry and excitotoxicity fit together to cause neuronal damage in many neurological diseases, of which amyotrophic lateral sclerosis appears to be an example.

Michael I. Posner reveals how new brain imaging techniques are changing the way cognitive psychologists think about classical psychological problems; Joseph B. Martin describes the power of molecular genetics in elucidating the basis of over 40 genetic neurological diseases; and James W. Putney Jr. compares and contrasts the biochemical control of Ca^{2+} in excitable and inexcitable cells. Mircea Steriade, David A. McCormick, and Terrence J. Sejnowski describe how a synergistic combination of physiology and modeling has begun to unravel the workings of the sleeping brain, while Keiji Tanaka reviews the recent thinking about how the brain recognizes the identity of objects.

To protect the brain when it is healthy and to heal it when it is ill are the worthy goals of neuroscientists, and the new frontiers of neuroscience, a few of which are described in this issue, are encouraging signs of progress toward that goal.

As we learn more about the incredible computer that is our brain, it will be important that nonscientists understand some of the implications and limitations of this work. Manic depression, an illness that cannot be successfully treated by counseling or psychiatry, is very responsive to the chemical lithium. Schizophrenia, which in the past had led to people being restrained in straitjackets in mental hospitals, can be treated by drugs that allow patients to walk around freely and pursue routine activities. Most of these drugs have serious side effects, so better drugs are needed. For some mental illnesses, like Alzheimer's disease, there are no drug treatments as yet but basic research is proceeding rapidly, and there is hope that help will soon be available to the increasing number of victims of this disease.

Chemical changes in the brain underlie all thinking, learning, and behavior, whether normal or pathological. The distinction between a normal state and a pathological state is one between benign chemistry and malign chemistry. The aging Alzheimer's patient, the homeless schizophrenic, the aphasic child, the depressed adult—all those whose brains are not functioning properly—will benefit from advances in neuroscience. Not all the homeless are mentally ill, but some are and retraining programs are not likely to help them. Not all the aged will have memory problems, but help for those who do will come from advances in the neurosciences. We need more understanding of diseases of the brain so that judges with an inadequate knowledge of elementary science do not release criminals who have stabbed a tennis star in the back or who have suddenly been "cured" by being nice to a psychiatrist. The decade of the brain will not see a complete understanding of all mental processes, but the opportunities are immense, as are the potential benefits to society.

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