Impacts of Neuroscience

Introduction

Neuroscience is the study of the nervous system, how it affects behavior, and how it is affected by disease. The goal of neuroscience is to define and understand the continuum from molecule to cell to behavior. New tools available to scientists promise to clarify some of the mysteries of how behavior is related to molecular, cellular, and electrical events in the brain.

The 50 million Americans with disabilities caused by neurological and psychiatric diseases provide compelling justification for studying diseases that affect the nervous system. Damage to the nervous system from exposure to toxic agents, both at work and in the environment, is receiving renewed attention from policy makers as knowledge increases. Neuroscience research may contribute to the solution of some problems related to crime and substance abuse. * The health and productivity of the American work force may be altered by application of principles derived from neuroscience. The multiplicity of ways in which understanding human behavior can impact on society underscores the need to understand the concepts of neuroscience and how that science relates to public policy. How social and political institutions will face the challenges brought by new knowledge based on neuroscience cannot be predicted, but future options will be determined, in part, by actions taken now.

Why is neuroscience important now?

The wide diversity of applications of knowledge about behavior and other brain functions would make neuroscience interesting at any point in time. Neuroscience is especially important now because in addition to intrinsic interest in the nervous system, the field has been developing at an increasingly rapid pace. Progress over the past decade has exceeded expectations by a wide margin because of newly available scientific techniques, innovative institutional arrangements for studying the nervous system at universities, and cooperation among different scientific disciplines. Continued rapid progress is likely if present levels of support for research are maintained.

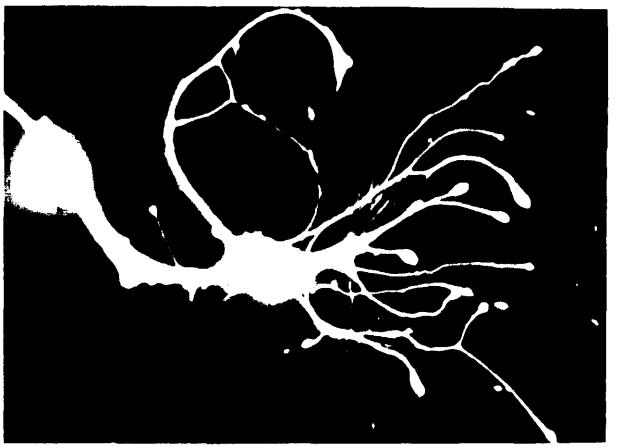

Photo credit: Stanley 8. Kater, Department of Zoology, University of Iowa

Identified neurons from *Helisoma* growing in cell culture and stained with a fluorescent antibody to reveal the presence of the transmitter serotonin

Many applications of neuroscience research may come to fruition in the next decade. Such applications may include new pharmaceutical agents, improved human factors engineering, improved pesticides, and prevention of mental disabilities due to prenatal events or toxic exposures. Improved treatment of psychiatric disorders may benefit many potential patients, Better understanding of cognitive abilities, mood, and memory may permit personal control of such functions or at least elaboration of why control is not possible.

As these applications are realized, the risks and ethical issues raised by advances in neuroscience may well become more evident and pose new questions for public policy. This background paper is an attempt to outline the scientific basis of neuroscience, to describe some of its poten-

"Substance abuse refers to deliberate use of drugs or alcohol, smoking, inhalation of solvents **("glue sniffing"), and other potentially damaging substances,**

tial applications, and to identify some of the ethical questions that may arise so that policymakers can better anticipate issues that may emerge.

Basis for congressional interest

Congress, and other branches of the Federal Government, are involved with neuroscience in several ways. Most funding for basic neuroscience research in the United States is channeled through agencies of the Federal Government. Payment for medical costs due to disorders affecting the brain is accomplished through the Federal agencies that manage the Medicare, Medicaid, and mental health programs. Congressional legislation has provided the backbone for regulatory actions that have reduced illness and accidents (and thus health care costs) by preventing exposure to chemicals that injure the nervous system. Congress has expressed concern for public safety in hearings on the nuclear and airline industries, citing the potential for accidents due to irregular work hours and disregard of scientific knowledge about daily biological rhythms. Use of drugs that affect mental function is a policy concern for several levels of government; regulation of drug laws, enforcement of drug abuse statutes, and payment for treatment of drug addiction are shared among Federal, State, and local governments.

*Photo credit: Dennis Landis, **Department** of Neurology, Massachusetts General Hospital*

A view of the interior and membrane of nerve cells in the cerebellum. This photograph was taken by an electron microscope of a special preparation of tissue called "freeze fracture"

The diversity of ways to apply neuroscience is reflected by the various congressional activities related to neuroscience. Over the past year, hearings on funding of neuroscience research have been held before authorizing and appropriations committees of both the U.S. House of Representatives and the U.S. Senate, Three committees have held hearings on various aspects of Alzheimer disease, Applying neuroscience research to scheduling of shift workers was the subject of one recent hearing; testimony reviewing the possible relationship between acid rain and injury to nerve cells was heard in another. Numerous hearings on environmental exposure and pesticide regulation have been convened.

The optimal mechanism for funding biomedical research has been a topic of extensive political debate. This has resulted in competing bills that mandate different levels of congressional involvement in funding decisions for the National Institutes of Health (NIH), the largest Federal agenc,y that supports biomedical research. Several different congressional bills creating a Federal agency for scientific and public discussion of topics related to biology and bioethics have been introduced.

All these congressional activities potentially affect, and are affected by, developments in neuroscience. Each of the topics summarized in this background paper is within the purview of some congressional function. One purpose of this summary is to point out the role of neuroscience research and its applications in these many congressional activities.

Several Federal agencies have identified neuroscience as an important and rapidly evolving field. In 1982, the Office of Science and Technology Policy (OSTP) selected neuroscience as one of

Photo credit: Dennis Landis, Department of Neurology, Massachusetts General Hospital

View of glial cells growing in tissue culture taken by a scanning electron microscope

seven areas for review by the National Academy of Sciences* (l). The OSTP report and others issued by branches of the Public Health Service and the National Science Foundation (NSF) document rapid advances in neuroscience research.

Relationship of this background paper to the OTA aging study

This background paper is part of an assessment of Technology and Aging in America by the Office of Technology Assessment (OTA). The prevalence of diseases affecting the brain, primarily psychiatric and neurological diseases, is projected to rise in coming decades, as the population ages, because age increases the risk of developing depression, dementia,** and other brain disorders. Because Americans are living longer, they run greater risks of developing the diseases of old age. Greater numbers of people reaching old age and rising average longevity both contribute to the increasing prevalence of mental and neurological diseases. Developments in neuroscience therefore may affect the health and well-being of the elderly population far more than the general population. Assessment of biomedical research on neurological and psychiatric diseases is thus an integral part of understanding these future changes.

A workshop was conducted on policy implications of neuroscience research as an element of the assessment of Technology and Aging in America. Because OTA evaluates indirect, as well as direct, impacts of science and technology, participants discussed not only the medical risks and benefits of neuroscience for the elderly, but also several relevant social, medical, industrial, and public policy issues. *

Organization of this paper

Several papers on various aspects of neuroscience were written by contractors in preparation for the workshop. Some of these papers, together with chapters prepared by OTA, are printed under separate cover as *Impacts of Neuroscience: Working Papers,* available from the National Technical Information Service. The papers are titled:

- A Primer of Neural Function;
- Medical Impacts of Neuroscience;
- New Technologies in Neuroscience;
- Social Impacts of Neuroscience; and
- The Federal Role in Neuroscience.

This publication summarizes the above papers, gives further background on selected topics, and includes points raised in discussion at the workshop.

An introductory description of neuroscience is followed by a review of selected applications and other topics related to neuroscience, emphasizing the role of the Federal Government.

• A report was prepared by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences, highlighting some of the most promising areas of research in neuroscience. It was used to brief George Keyworth, director of OSTP, and was intended, in part, to provide guidance for the Office of Management and Budget and the White House.

•• Dementia is the diminution of higher mental functions such as memory, or the ability to calculate and think.

***Discussion of chemical and biological warfare was not included on the workshop agenda because it would be impractical for the Health and Life Sciences Division of OTA to arrange for review of classified information in an open workshop. The topic of chemical and biological warfare, while extremely important, therefore was omitted.**

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