Nuclear Bravado

Nuclear Blackmail and Nuclear Balance. RICHARD K. BETTS. Brookings Institution, Washington, DC, 1987. xiv, 240 pp. $28.95; paper, $10.95.

At a time when many American scientists are deeply engaged in analyses of public and private proposals for nuclear arms control, Richard K. Betts poses pointed questions about nuclear saber rattling. His book is about attempts by the United States and the Soviet Union to exert leverage on the outcome of international crises by flexing their nuclear muscles. Since the bombing of Hiroshima and Nagasaki, he counts more than a dozen cases "in which some sort of nuclear threat was used as a sparring tactic in tense confrontations" (p. 2).

Betts describes and analyzes these incidents, concentrating upon threats by the United States for which there is "a fair amount of reliable evidence." Instances in which the Soviets attempted nuclear coercion include threats that he discounts as bluster because they were issued after a crisis had peaked (p. 7). Among the lower-risk cases he catalogs the Berlin blockade (1948), the Korean War (1950–53), the crises in Indochina and the Taiwan Straits (1954–55), in Suez (1956), and in Lebanon and the Taiwan Straits (1958), and the Soviet-Chinese border clashes (1969). More serious were the two Berlin crises (1958–61), the Cuban missile crisis (1962), the Middle East War (1973), and the Carter Doctrine regarding defense of the Persian Gulf (1980).

Throughout the book, Betts contrasts two theories offered to explain American use of nuclear threats: the balance of interest theory and the balance of power theory. Advocates of the former expect that if both sides can inflict severe nuclear damage on each other, the balance of military and nuclear power will be less important to either side than how much it stands to lose if it backs down. Advocates of the latter theory expect that a nation that has more to lose from nuclear war than it can gain will not start one, whatever else is at stake. He shows that both explanations are partially valid—the former accounts for American decisions to resort to nuclear threats and the latter for the Soviet posture of risk aversion—but that neither is adequate to account for the behavior of both sides. On the basis of his examination of specific cases, Betts observes that American leaders have straddled the boundary between these theories. "As political animals they were willing to gamble rather than to invite defeat, but they hedged their bets"; they have shown "more flexibility and less coherence in practice than theorists do in principle" (p. 13). Uncomfortable as it may be, the theorists must find ways to consider the messy, sometimes unpredictable political factor.

Betts cautions that the fact that nuclear threats seem to have worked in the past does not mean they will work now. One good reason is the transition of the United States from domination to parity in strategic nuclear weapons, despite the "overlapping conceptual confusions and political evasions" about what nuclear superiority and parity mean. Nonetheless, he tries to find lessons in past direct or hinted threats and to think about how nuclear blackmail might again enter into relations between the superpowers. His final message calls for restraint: "If a whiff of nuclear blackmail enters at all in the midst of conflict, the action should have a purpose. If the purpose is not serious, why depreciate the nuclear currency, and why tempt fate?"

Nuclear Blackmail and Nuclear Balance helps to fill a gap in our understanding of nuclear weapons and their uses, while reminding us that nuclear bravado could lead to an unintended unleashing of these weapons. Within the aviary of nuclear arms controllers, Betts seems more likely to bring comfort to the doves and owls than to the hawks.

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Making Space Pay

Space Resources. Breaking the Bonds of Earth. JOHN S. LEWIS and RUTH A. LEWIS. Columbia University Press, New York, 1987. xviii, 418 pp., illus. $30.

In a narrow sense *Space Resources* concerns the existence of resources in the portion of the solar system near Earth and their potential for supporting activities in space—both near to and far from Earth. The authors' point is that there are plenty there and they can be of major help in carrying out and paying for the space program. Space resources are defined as almost any usable material or energy that can be found in space. The most immediate sources are the moon and near-Earth asteroids for materials like metals, oxygen, and water and the Sun for energy. There are also resources to be scrounged from objects launched into space and abandoned, such as unspent fuel in the external shuttle tanks and the container itself. John S. Lewis, a chemist and planetary scientist, is especially credible discussing the composition of raw materials in space and the refining processes that can make them usable.

In a broader sense, though, this book concerns what is wrong with the U.S. civilian space program and NASA, and it offers a plan to correct these faults. These seemingly disparate topics, space resources and space programs, are nicely blended into a coherent story, with remarkably broad coverage. The book treats the questions of how and where NASA went wrong. It argues that NASA does not now carry out its own charter, which is research and development, but instead attempts to be in a service industry and neglects or even destroys its research effort, as epitomized by the near demise of the Solar System Exploration Program. Through discussion of the history and motivations for space races, the authors show how the unrelated and dead-end U.S. projects (for example, Apollo) were actually carried out, as compared with the planned orderly progression toward occupation and utilization of space.

A very specific and far-ranging set of proposals is given for getting the U.S. program back on track, paying for itself and proceeding with a productive development of space. The authors carefully outline 30 specific steps, some with several subdivisions. The first is obvious and not unreasonable, namely, that "Congress, the Executive Department, and NASA must confirm the commitment of NASA to abide by its charter" (R&D). Additional steps deal with enhancement and redirection of manned activities in space and development of basic enabling technology. Finally, considerable emphasis is given to the internationalization of the space program, which has already happened and is leaving the United States behind.

Lewis and Lewis treat each topic with blunt logic, numbers and facts, and some humor. The arguments and proposals are easy to understand, even if some readers may not agree with them. The book is unusual in that it treats scientific and political topics equally well and in an integrated way. There is credibility, basis in fact, and soundness of logic. The question of whether our institutions as now constituted are able to recognize the errors and implement the solutions, however correct they may be, is not treated—and perhaps just as well. This is a book by a scientist and a science writer, not by a politician or a manager. On the topic of the decaying U.S. civilian space program, the problems are so numerous that there is a tendency for those involved to become emotional and shrill; the authors avoid that trap for the most part. I believe

this book is well worth reading—and may even be enjoyed—by a broad spectrum of scientists and engineers, thoughtful bureaucrats, and politicians.

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Advances in Neurochemistry

Monitoring Neurotransmitter Release during Behavior. M. H. JOSEPH, M. FILLENZ, I. A. MACDONALD, and C. A. MARSDEN, Eds. VCH, Deerfield Beach, FL, and Horwood, Chichester, U.K., 1986. 270 pp., illus. $57. Ellis Horwood Health Science Series. Based on a meeting, Oxford, U.K., Sept. 1984.

Neurochemical Analysis of the Conscious Brain. Voltammetry and Push-Pull Perfusion. ROBERT D. MYERS and PETER J. KNOTT, Eds. New York Academy of Science, New York, 1986. xii, 560 pp., illus. $40. Annals of the New York Academy of Sciences, vol. 473. From a symposium, New York, April 1985.

These two volumes focus on methodological advances that open up new opportunities for neurochemistry: the development of new methods of collecting extracellular fluid from brain and the application of electrochemistry to the detection of neurotransmitters.

Traditional neurochemical methods applied to postmortem tissues have been extremely useful in characterizing the static condition of the nervous system. However, because such measurements can be made at only a single time point per animal, they have been of limited use for relating neurochemical events to functional changes in physiology and behavior. Measurements of metabolite concentrations and turnover provide some insight into dynamic changes, but many animals have been needed to provide a time course, and individual differences in time courses are lost. Furthermore, measurements of biogenic amines in tissues cannot give a direct indication of neurotransmitter release, the variable often the most relevant with respect to function. Measurement of biogenic amines in plasma, urine, and cerebrospinal fluid has been of some assistance in these regards, but such measures are, at best, indirect indicators of neurotransmitter availability at target cells. Moreover, biochemical methods generally have been too insensitive for direct measurements on extracellular fluid. Although measurements of changes in electrical potential can provide the necessary time resolution, the neurochemical bases of electrophysiological changes often are difficult to determine, and release and neuronal firing rate may not always covary.

The problem, then, has been a technical one—how to measure the relevant variables with sufficient sensitivity and in freely moving animals. These monographs deal with both issues.

At the heart of the matter is the application of electrochemistry to the measurement of biogenic amines and their metabolites. When exposed to carbon electrodes poised at the appropriate voltages, these compounds undergo an oxidation to the quinones or quinone-imines. The number of electrons passed at the electrode surface during such an oxidation provides an index of the concentration of the biogenic amine. Such carbon electrodes can be used to detect and quantify these oxidizable compounds as they elute from a high-performance liquid chromatographic (HPLC) column. With the right conditions, detection in the low picomole range is possible.

The application of electrochemistry to measurements of biogenic amines has developed largely from work of Ralph Adams at the University of Kansas. Over the past several years, the work of Adams and others has led to three additional developments: analysis of ever smaller samples of tissue and plasma, analysis of extracellular fluid collected from brain regions by perfusion or dialysis probes, and direct monitoring of transmitter release via intracranial microelectrodes. We will comment briefly on the second and third of these.

The idea of brain perfusion was introduced nearly 30 years ago by Feldberg, Gaddum, and others. This approach has reached its most advanced state with extremely small push-pull perfusion systems and with the development of intracerebral dialysis. In the latter technique, tiny sections of dialysis tubing are implanted in specific brain regions and a solution is slowly infused. This perfusate equilibrates with extracellular fluid, and analysis of its contents can then provide an index of the concentration of specific substances in extracellular fluid. The development of this approach owes much to Urban Ungerstedt at the Karolinska Institute, whose innovative work in histology, pharmacology, and behavior had already left its mark on the field.

The alternative to perfusion is the use of miniature carbon electrodes that can be implanted directly into the brain. In theory this should permit the direct monitoring of extracellular fluid. The problem, however, has been that, in the absence of the chromatographic separation, all the specificity must be provided by the electrode. At first many of the electrodes that were used responded to a multitude of compounds, leading to much debate about the exact nature of the species being detected. During the past few years, however, there has been considerable progress in the development of more specific electrodes, including electrodes coated with anion-suppressing substances (Adams; Blaha and Lane), carbon fiber microelectrodes and the application of special scanning techniques (Wightman; Kruk), and electrolytic pretreatment of microelectrodes (Ganon).

All the principal researchers mentioned above are represented in these two valuable volumes. In *Monitoring Neurotransmitter Release during Behavior* the section on investigations of the central nervous system, which occupies almost half of the book, contains a number of particularly interesting contributions from groups that have pioneered the use of these techniques, among them those of Bradford, Curzon, Fillenz, Freed, Marsden, and Ungerstedt. The initial chapter of this section, by Maidment *et al.*, serves as an introduction to intracerebral dialysis and voltammetry, and a final commentary by Korf provides a useful summary of the various approaches currently being used.

A separate section contains papers dealing with the sympathoadrenal system. Hjemdahl provides a review of the variables involved in HPLC measurements for assessing sympathetic activity through measurements of adrenergic activity, and Landsberg and Young discuss measurements of catecholamine turnover. The volume concludes with reports from workshops on recent developments in HPLC analysis and in vivo monitoring techniques. Of particular interest is the description by Kruk of fast-scan cyclic voltammetry, which is becoming an important technique for use with in vivo electrochemistry.

Neurochemical Analysis of the Conscious Brain focuses exclusively on the analysis of the extracellular fluid. The introductory section includes a plenary lecture by one of the "fathers" of perfusion techniques, Feldberg, as well as several overviews: push-pull perfusion systems in awake animals by Meyers, voltammetry in the brain by Adams, application of voltammetry to central nervous system pharmacology by Lane and Blaha, and electrophysiological recordings made in freely moving animals by Jacobs.

The second section of the book focuses on analysis of the brain's catecholaminergic systems. In addition to several papers on voltammetry and push-pull perfusion, there is a paper by Marsden *et al.* on intracerebral dialysis. Later sections focus on factors influencing the release of catecholamines, serotonin, peptides, and amino acids. Bio-