trade-offs between different options are often impossible to weigh. Moreover, a leader's choices will be affected by the various emotional pressures and cognitive distortions to which we are all susceptible. Even with perfect information, imperfect decisions will be made.

As a result, the attempt to deter a potential adversary can go awry rather easily. Leaders may underestimate either how bad the punishment will be or how likely it is to be carried out. In either case, deterrence may fail because the risks will be seen as small. To make matters worse, a defender's efforts to make its threats more credible or dangerous may be no help at all: the adversary may simply conclude that war is inevitable and begin searching for a favorable opportunity to strike.

These misperceptions can be traced to several common psychological phenomena. Human beings interpret reality through a variety of cognitive images; we try to fit new information into familiar concepts and categories. Thus deterrence can fail if policymakers interpret ambiguous warnings incorrectly, by forcing new evidence to fit with powerfully held but inappropriate beliefs. Alternatively, we tend to ignore information that raises psychologically difficult choices while welcoming evidence that suggests that earlier decisions are correct. As a result, policymakers may ignore warnings no matter how clear they are if accepting them would force painful decisions or would challenge important values. In either case, deterrence can fail despite a defender's repeated warnings and obvious military capability. And because policymakers on both sides will be subject to these psychological distortions both are likely to be surprised when it does.

A major strength of this work is the effort devoted to stating these hypotheses clearly and evaluating them through a number of interesting case studies. Given the plethora of abstract models and dubious statistical manipulations that now abound in this field, the creative use of history is always refreshing. Stein's examination of the War of Attrition and the 1973 Yom Kippur War shows how the Israelis consistently exaggerated their ability to deter Egypt because the Egyptians either exaggerated their own military prospects or were willing to suffer considerable losses to achieve small political gains. According to Lebow's account of decision making in the Falklands War, similar misperceptions plagued both Argentina and Great Britain. Despite abundant evidence, the British failed to realize that Argentina was preparing to attack the islands. At the same time, the Argentinians were so confident that Britain would not fight that they gave little or no thought to what they would do if they were wrong. Given how completely both sides misread the other's intentions, the Falklands War seems as inevitable in retrospect as it was unexpected at the time.

Despite these strengths, the effort to blend theory and history is not entirely successful. First, as the authors acknowledge, many of their criticisms of deterrence theory have been made before (for example, in their own earlier work and in a seminal study by George and Smoke). Second, their reliance on psychological theories of misperception to explain the failure of deterrence ignores a number of alternative hypotheses that may be equally (or more) persuasive in some cases. For example, leaders may misperceive a situation not because they have misunderstood the information available to them but because they have been given misleading information by self-interested bureaucratic players. In other words, misperceptions rooted in the organizational structure of the modern state may play as great a role in failures of deterrence as the psychological quirks of individual leaders. Lebow's earlier study of crisis behavior explored this issue in some detail, and Snyder's contribution to this volume points out the understandable tendency of military organizations to exaggerate the efficacy of force as a means of enhancing deterrence. By focusing primarily on psychological sources of failures of deterrence, however, this study does not come to grips with the complementary but distinct explanations provided by organization theory.

A more significant problem is the inherent difficulty of identifying if and when psychology is the real villain in a given failure of deterrence. The claim that a given decision was the product of an irrational choice inevitably reflects the analyst's own evaluation of what a "rational" response to the situation would have been. Thus Stein argues that Israeli deterrence failed in 1969–70 because "Egyptian calculations were so flawed that they defeated deterrence." She attributes these flaws to wishful thinking and other cognitive distortions. But this ignores the fact that both the War of Attrition and the Yom Kippur War made a great deal of sense from Egypt's point of view, even if Egyptian calculations were incomplete and optimistic. Indeed, a good argument can be made that Egypt "won" both wars, in terms of its larger political objectives. As Stein admits, Egypt faced "an intolerable dilemma" by remaining at peace, given Israel's continued occupation of the Sinai. Going to war was less an "irrational choice" than a costly necessity.

This raises a final issue. How much can we really learn about nuclear deterrence by examining the behavior of leaders in conventional conflicts? For the nuclear powers, no political objectives could be worth a nuclear exchange. Even if policymakers do not calculate perfectly, one does not have to be all that smart, well-informed, or rational to figure this out. But in a purely conventional conflict, choosing to "roll the iron dice" is occasionally the best option available. The authors are quite right to emphasize how myopic the vision of leaders can be, but we should recognize that they have drawn their data from events where miscalculation is both easier and less severely penalized.

This shifts the focus of the deterrence problem away from psychology and back toward the political imperatives that decision makers always face in weighing a decision for war. To their credit, the authors recognize the paramount importance of political factors. As Lebow points out in his conclusion, decision makers (and scholars) should pay far more attention to the question of how they can avoid placing adversaries in the position where they perceive no choice other than to go to war, irrespective of the apparent cost of doing so. Because leaders backed into a corner will be even more prone to miscalculation, credible reassurances may be just as important as credible threats in making deterrence work. Unfortunately, as Lebow reminds us, the art of reassuring others has received much less attention than the art of making threats. That insight alone is something that both decision makers and scholars might well ponder further.

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A Plea for Applied Science

Lost at the Frontier. U.S. Science and Technology Policy Adrift. DEBORAH SHAPLEY and RUSTUM ROY. ISI Press, Philadelphia, 1985. x, 223 pp., illus. $19.95; paper, $13.95.

The concern of this book is with a major issue in national science and technology policy, the place of applied science. "In our view," the authors declare, "today's declining high-technology trade balance, the fragility of U.S. industries, and the serious lack of public understanding of science show that the United States has not exploited the frontier of science as well as it might have" (p. 2).

The authors, one a journalist and the

other a materials scientist and laboratory administrator, characterize their approach here as "science criticism." They are "presenting a case, based on our discussions with a number of scientific managers in government, industry, and universities" (p. 2) and have (p. 139) "reserved the right . . . to be outrageously unscientific and play our hunches, aided by our experience, research, and exchange of ideas with experts." (Brief responses from some of those experts are included at the end of the book.)

The authors believe that the elevation and success of basic science have led to an undervaluing of applied science, engineering, and technology. They trace this situation to Vannevar Bush's 1945 "blueprint" for federal science policy, *Science—The Endless Frontier*. Bush's report was indeed a call for federal support of basic research. However, the authors note, "It does not treat basic research in a vacuum, but as one of the steps in a chain of endeavor that leads to industrial advance, better health, and stronger national defense" (p. 7). Unfortunately, Bush cited a "perverse law," this being that "applied research invariably drives out the pure" (p. 15). Shapley and Roy take the view that the converse may be happening in today's science policy environment.

The problem began with the use to which Bush's ideas were put in the 1950's. The scientific profession—based in the universities and led by such spokesmen as Alan Waterman, first director of the National Science Foundation—created an ideology to rationalize support for basic science. This ideology reached its zenith with President Reagan's science adviser George Keyworth, who strongly supported basic research and generally opposed federal involvement in nondefense applications. The administration's assumption is that industry will serve the function of creating useful technologies.

In effect, Shapley and Roy contend that the interests of basic scientists and the present conservative political leadership work in tandem, with the United States the loser. The patterns and ideology of the past 40 years will not be adequate to the realities of the future. In the meantime, other nations, particularly Japan, are showing that an applied research policy can pay dividends even in the absence of a significant basic research effort.

What is to be done? "First, U.S. science should be reorganized to give equal weight to undirected basic research, purposive basic research, applied science, engineering, and technology." And "Second, there should be a change in the values of our scientists, particularly young people starting their careers, to stress the *interconnections* among disciplines, institutions, and across artificial barriers and obstacles now separating basic and applied science, engineering, and technology" (p. 18).

Shapley and Roy are with those who believe the federal government, rather than the market or state and local governments, should play the lead in applying science to national problems. There is relative consensus today that the federal government is relevant at the "front end" of the research and development continuum and that industry and other users should dominate at the "back end." The issue is who does what, under what conditions, in between. Recent attempts to achieve agreement have focused, as the authors have, on concepts such as "purposive" basic research and "generic" technology. Some federal efforts relevant to applied research have been launched (for example, the new NSF program of Engineering Centers). These are exceptions to the general trends, however, and in the absence of a coherent national policy applied research programs rise and fall on the winds of political sentiment, seldom lasting long enough to accomplish what their creators would have hoped.

Shapley and Roy's book is not as deep and penetrating as many readers might like, and their broad-brush treatment may militate against their winning converts. After all, the connections between basic research and applied science, engineering development, and operations are elusive and complex, and there are numerous examples of failures in federal applied research efforts. Moreover, it is almost impossible to separate applied research from the purposes of policy in which it is embedded. If there is to be change, its potential beneficiaries must assert their claims more forcefully. Who will gain from the reforms Shapley and Roy espouse? Who speaks for applied science in America? Toward what ends? Whose ends? What is the applied science constituency? What are the incentives for the scientific profession to shift from the relative continuity and comfort of basic science to the conflict and change of applied research?

These questions notwithstanding, Shapley and Roy have highlighted an important issue. There is a need for a national science and technology policy that provides a framework for linking not only science and technology but also federal, state, local, and private institutions. Such a policy requires political and administrative leadership and a long-term approach. It is still not clear what should fill the gap and how. But this book may encourage a better debate of the issues.

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The American Telephone Industry

The Telephone Enterprise. The Evolution of the Bell System's Horizontal Structure, 1876–1909. ROBERT W. GARNET. Johns Hopkins University Press, Baltimore, 1985. xxvi, 212 pp., illus. $22.50. The Johns Hopkins/AT&T Series in Telephone History.

The Anatomy of a Business Strategy. Bell, Western Electric, and the Origins of the American Telephone Industry. GEORGE DAVID SMITH. Johns Hopkins University Press, Baltimore, 1985. xxiv, 238 pp., illus. $20. The Johns Hopkins/AT&T Series in Telephone History.

From Invention to Innovation. Long-Distance Telephone Transmission at the Turn of the Century. NEIL H. WASSERMAN. Johns Hopkins University Press, Baltimore, 1985. xxvi, 162 pp., illus. $17.50. The Johns Hopkins/AT&T Series in Telephone History.

The history of the American telephone industry is, of course, largely the history of the Bell System/AT&T, its attainment of monopoly status, and the successive challenges to its hegemony by dint of early competition, changing technology, and the advent of public regulation. The dramatic divestiture decision of 1983, the effects of which are revolutionizing the communications sector, closed out a distinctive epoch in American business history. The early landmarks in the history—all of which are reconsidered in the three books under review—included the 1879 market-division agreement by which Western Union left the telephony field to the Bell System; the Western Electric agreement of 1882, by which Bell acquired a manufacturing arm; the formation in 1885 of AT&T as a long-distance service company and keystone of the projected national network; and AT&T's acquisition of the Pupin circuit-loading patent in 1900, vital to restoring the national hegemony of the company in the telephone business.

To the historian of American law, the "natural monopoly" characteristics of franchised telephonic communications systems make the AT&T story a fascinating case