the imposed ones. Stability will be lost and attempts to overcome the conflict will ensue. This will be true even of attempts at self-control, since the individual is unaware of his own internal organization. Finally, although reinforcement is the only way to exert external control, humans will discover who metes out rewards and punishments and will use cunning or force to circumvent the process.

The trouble with Skinner's program, claims Powers, is not that the world will not accept his view, but that it already has accepted it, since there is no other means of control and control is what we demand. But constant diddling with control systems leads inevitably to conflict and ultimately to revolt. Salvation can be found only in stopping all attempts at control and influence.

Powers's hope was to reconcile the mechanistic and the humanistic conceptions of man. Mechanists (some of them) will like the model and humanists (some of them) will like the conclusions, but I am afraid that the rapprochement has not been achieved. There are more assumptions than those embodied in the model lying between it and the final message. What these are is not made transparently clear, but they involve, at least, assumptions about the reorganizing principles and about man's perception of other men as special entities. I must confess that I do not even understand what Powers means when he politely suggests that all attempts at control be stopped. The only alternative he offers is cooperation, but the line between the two has never been made clear. Nor do I understand why animate controllers are more troublesome than inanimate ones, or how we will alter a control-crazy society without influencing it. Perhaps my control system is caught on a local stability plateau from which I cannot see clearly. Others may do better and I hope they will try. Not urge or suggest or demand, I suppose; but hope.

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Restorative Processes

The Functions of Sleep. ERNEST L. HARTMANN. Yale University Press, New Haven, Conn., 1973. x, 198 pp., illus. Cloth, $8.50; paper, $2.95.

Why do we sleep? Although researchers have been busy describing how we sleep, many regard it as improper then to inquire whether sleep should have purpose or functions, physiological or psychological. In this book, Hartmann argues (and I agree with him) that there is a requirement for sleep and that we must therefore ask what needs it serves. He draws on the available observational evidence in theorizing about different functions for the two kinds of sleep, usually termed REM and NREM sleep in the United States. He prefers his individual terminology of S (synchronized) and D (desynchronized) for these, mentioning the synonyms only in a footnote.

Hartmann writes clearly and certainly without excess of personal diffidence. A reader could be excused for thinking that Hartmann alone has suggested that S sleep must be linked with general restorative anabolic processes and D more specifically with brain synthetic processes. What is original in this book is its attempt to explain why S always *precedes* D. Hartmann proposes that macromolecules synthesized in the brain during S are, in a second step, utilized "in processes of restoration and reconnection" of the cerebrum during D. In a speculative field some inconsistency between chapters is allowable: at one time Hartmann appears to think that S is mainly related to general bodily synthesis but elsewhere says that with S increased synthesis probably occurs especially in the brain. However, he does not refer to the cerebral blood flow, which is actually much greater during D. This would be compatible with increased oxidative metabolism during D, hence with D's being more important for cerebral restoration than S.

It is Hartmann's claim, based largely on his own research, that intellectual and emotional tiredness cause longer sleep and, specifically, that more D is a response to greater cognitive or learning activity (he does not mention the work indicating that perceptual deprivation enhances D). He first describes the evidence for his claim as "suggestive" but later allows himself a "probable" when marshaling support for the proposal that in D new structural or enzymatic protein is laid down in order especially to restore brain catecholaminergic receptors or presynaptic axonal endings exhausted during waking effort. It is in his review of catecholamines and sleep, and in his arguments therefrom, that I find him at his most persuasive.

Few sleep researchers have been biochemists, and when Hartmann writes that the duration of S and D is roughly the amount of time necessary for brain macromolecular synthesis and structural change I can imagine biochemists stirring uneasily. Yet these remarkably regular durations exist: Hartmann has not hesitated to face the challenge, nor has he shunned paths that angels might fear to tread.

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Origins of Life

Molecular Evolution. Prebiological and Biological. DUANE L. ROHLFING and A. I. OPARIN, Eds. Plenum, New York, 1972. xx, 482 pp., illus. $24.

This book is a collection of 35 papers dealing with diverse topics related to the general question of chemical evolution which were contributed in honor of S. W. Fox on his 60th birthday. The papers are organized into the following groupings: History and Scope, Thermodynamic and Philosophical Considerations, Micromolecules, Macromolecules, Protocells and Cells, Academic Aspects, and finally Man and Evolution. The section on macromolecules is the longest (about 35 percent of the book), while that headed Man and Evolution is only three pages long. The scope and the style of the contributions are varied. Some authors concern themselves with an investigation of one particular point and have contributed papers such as might have appeared in a journal. Others are reviews of their authors' own research over an extended time period. A third group are general discourses on topics related to chemical evolution by scientists who are interested in the subject but are not actively carrying out research in it.

One advantage of a compilation of this type is that it allows the inclusion of a broad spectrum of contributions which do not necessarily fit together in a logical array. For example, I was sur-

prised and impressed by the detailed discussion of the biochemistry of *Flavobacterium thermophilum*, a bacterium with an optimum growth temperature of 85°C. Discussion of the amoeba-flagellate transformation and the peroxidase enzyme myeloperoxidase was also unexpected. Some unusual discussion more closely related to the general theme of the book includes a chapter by L. Pauling and E. Zuckerkandl on chance in evolution and chapters by C. Welch and A. Vegotsky dealing with the role of topics related to chemical evolution in high school and college courses. Although the majority of the contributions would be of more interest to the specialist, the general reader could get a perspective on the field by reading those in the section dealing with History and Scope. In particular there is a lucid discussion by R. Young of the philosophy and scientific goals of the NASA planetary biology program. The subsequent paper by N. Pirie dealing with the problems of recognizing life in places remote from the earth is especially pertinent to Young's discussion.

The first chapter of the book is a brief biography of S. W. Fox by the editors which reviews his contributions to prebiological chemistry from 1953 to the present. Fox has been influential since a number of his students and postdoctorals have continued to work in this area, and some of them have contributed chapters to this book. All these contributions demonstrate that Fox has earned the respect and admiration of those who have worked with him.

Fox has worked diligently to document and popularize his view of the origins of life. In brief he postulates that amino acids formed from the constituents of the earth's primitive atmosphere were thermally copolymerized in the dry state to a protein-like material he calls "proteinoid." He further postulates that the "proteinoids" were washed into an aqueous medium where under certain conditions they form organized units ("microspheres") which he believes exhibit some of the properties of cells. Thus he feels that protein was the basis for the origins of life and that nucleic acids came later as living systems became more complex. This view is outlined in greater detail by his son, J. L. Fox, in this volume and is discussed more fully by S. W. Fox and K. Dose in *Molecular Evolution and the Origins of Life* (Freeman, 1972).

S. W. Fox's view of chemical evolution is not universally accepted. I can recall that some of his students at Florida State University experienced difficulty with their Ph.D. committees because the faculty did not accept his theory and his approach to research. I suspect that this may be one of the reasons for D. Rohlfing's comment on the early research that "many hurdles—not all of them scientific—have been overcome in the course of this research." Obviously there will be no final answer as to which theory is the correct one for the origins of life. In an area rich in theory but poor in experimental fact one can only hope to gain perspective by sampling a number of views. The uninitiated would do well to at least contrast the ideas of S. W. Fox with those expressed by S. L. Miller and L. E. Orgel in *The Origins of Life on the Earth* (Prentice-Hall, 1973). Miller and Orgel argue, for example, that nucleic acids were essential for the origins of life.

In conclusion, this book provides some stimulating discussions of the origins-of-life question with much of the discourse centered around the approach pioneered by S. W. Fox. The specialist will probably want to obtain his own copy, but I suspect that a library copy will supply the needs of most others.

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