of course the diversity was in fact much greater; history simply trims it away.

Otto Selz was one who was trimmed. His works have never been translated into English. Seen through the eyes of G. Humphrey's 1950 book on *Thinking*, which was practically the only place where Americans could make contact with Selz, he appears to be simply another psychologist of the introspectionist period, worrying about problems of mind that are no longer of account. In fact, he also was reacting to associationism, and he attempted to provide a complete organization of methods whereby it was possible to see how the parts of thought get put together to effect the solution to a problem. His framework centers about solution methods, their hierarchical and sequential structure, and how each step plus the results it produces determines uniquely the next step. This is very much in line with modern attempts to lay bare the structure of information processing in human problem-solving by computer simulation.

The framework was also exactly appropriate to the study of the way humans think in playing chess. Adriaan De Groot, at that time both an international chess player and a student in psychology at the University of Amsterdam, collected a large number of protocols of humans deciding upon moves in a chess game. That is, the subject was presented with a chess position and asked to analyze and decide on a move while speaking his thoughts aloud, so that some record could be made. Then De Groot subjected this mass of material to an exhaustive analysis, in which he dealt in detail with the phases of the subject's investigation, the methods that he used, and the extent to which various features of the objective situation determined how he proceeded. This analysis, which became De Groot's doctoral thesis, is here finally available in English without essential modification (although with some additions). So Selz finally reenters the stream of active psychological research, in which his contributions can be seen in a new and better light.

But this leads to the major tale, although it can now be told in fewer words. Among its many consequences, the development of a science of information processing has led to the use of information-processing theories for human higher mental processes. Usually embedded in computer programs, these theories are the basis of attempts to model activities such as chess playing. Thus, they provide a technical matrix within which the kind of data that De Groot has obtained becomes extremely relevant. For the data would not excite an experimental psychologist grown up in the shade of behaviorism with statistical comparison as a security blanket. To be sure, De Groot tabulates a few comparisons, but these are all of relatively superficial features. Instead, the data are verbal behavior, and their analysis involves the extraction of their meaning against a background of inferred chess reality. This is an exercise that has a certain kinship with that of the archeologist. And the current ability to construct chess-playing programs (and others of more generalized capabilities) permits one to make use of the information so extracted—to assess the power and function of the methods—and to discover their fragmentary nature, when seen against the total demands of a program for actually playing chess.

The data are especially valuable because the subjects are not the college sophomores ubiquitous in American psychology, but are drawn from the upper ranks of the chess world: six grand masters, including two world champions (Euwe and Alekhine), five masters, and a number of others ranging from experts down to some of only modest skill. Thus the book has a good deal of intrinsic interest for those whose focus is chess, rather than psychology or information processing. The protocols for a majority of the sessions are included in an appendix.

What does the analysis yield? Not much in a highly precise form. There is clear evidence that search of consequences is a primary method of thinking in chess, and there is some characterization of the kinds of search strategies used. There is a non-obvious finding that it is not possible to distinguish the search behavior of grand masters from that of lesser players in superficial features of their "search trees." (They do select better moves.) This is followed by a demonstration that such players can be distinguished clearly by their ability to reproduce the chess positions after brief exposure. The data for this are a little thin but sufficiently provocative to warrant the attention given them.

There are a number of deficiencies in the study, of course. The data were recorded manually, since tape recorders were not available 25 years ago; the analysis is somewhat repetitious; and none of the current tools of analysis or concepts were available then. Still, wisely I think, De Groot refused to rework the material in any substantial way. He has added a 35-page epilogue that places the work somewhat in modern context. And he has labored hard (and successfully) to provide an adequate translation. It remains a gold mine for anyone working on human thinking and for anyone fascinated by chess. It is good to have it available in English.

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Extracting Information

The General Inquirer. A Computer Approach to Content Analysis. PHILIP J. STONE, DEXTER C. DUNPHY, MARSHALL S. SMITH, and DANIEL M. OGILVIE. M.I.T. Press, Cambridge, Mass., 1966. 671 pp., illus. Paper, $7.95.

This review contains information about the book it is reviewing and about the reviewer's opinion of the book. It may also contain information about the reviewer, about how he is attempting to affect the readers of the review, and perhaps about 20th-century America and the nature of *Science*. One way to retrieve some of this information is to read the review. Another way, to be preferred if the analysis is to be objective, reproducible, and suitable for testing some hypotheses about the psychological or sociological context in which the review was produced, is to describe the document with statistical or qualitative statements about its distribution of syntactic or semantic word classes. This procedure is one form of content analysis, more generally defined as "any research technique for making inferences by systematically and objectively identifying specified characteristics within text." The General Inquirer is a collection of computer programs which can be put together in a variety of ways to aid the content analyst by performing the lengthy data-processing involved in the analysis of large corpora.

It is important to note that the General Inquirer is not a contribution to linguistic theory, or a procedure for syntactic analysis, or for that matter a procedure for content analysis. It is, rather, a cleverly conceived collection

of subroutines that can be used to build, within a wide range, the procedure for content analysis that the user wishes to explore. The user supplies a dictionary of word categories (or uses one prepared for another application) which defines groups of words which he believes are indicative of some concept (for example, the category POSITIVE VALUATION may contain "good," "excellent," "desirable," and so on). He must then extensively edit the text to be processed, marking with tags the intended senses of ambiguous words, the referents of pronouns, and any syntactic features he wishes considered. He then decides what summary statistics are of interest—frequency counts by category, weighted frequency counts, or, most useful, frequencies of combinations of categories with constraints on ordering and nearness. Using the subroutines provided he constructs the program which will process his edited text. The General Inquirer provides some important operations, such as finding root forms of words by removing affixes, but does not do any sophisticated linguistic analysis.

How useful is this package of programs? Judging by the sample of applications reported, comprising 60 percent of the present book, it has been quite useful to a variety of social scientists, with some interesting results ranging from analysis of presidential nomination acceptance speeches to studies in psychotic language. Such broad application attests to the careful design, enthusiastic promotion, and ease of use of this tool.

This volume is, however, more than a description of the General Inquirer and its applications. The first part contains a thorough review of the history and philosophy of content analysis, being equally careful in pointing out its limitations and its potentialities. The techniques at present available can provide important information from a significant and ubiquitous source of data which in principle is much richer than the narrow channel provided by traditional methods of psychological experimentation. It is obvious, however, that such gross techniques alone cannot recover all, or even the most important, information from these data (for instance, whether an author's arguments are valid, his assertions true, and his intentions moral).

The authors of the book assume the reader knows nothing about anything and proceed to tell him a great deal. While this makes the book long-winded, it also makes it comprehensible to a wide audience from the sciences and the humanities.

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Statistical Ensemble

Differential Space, Quantum Systems, and Prediction. NORBERT WIENER, ARMAND SIEGEL, BAYARD RANKIN, and WILLIAM TED MARTIN. M.I.T. Press, Cambridge, Mass., 1966. 188 pp., illus. $7.50.

Several apparently unconnected topics in mathematics and mathematical physics are drawn together, in this book, by their common reliance on the concept of the statistical ensemble. These topics are (i) the mathematical theory of the Brownian motion process (where the ensemble is composed of individual Brownian paths), (ii) analysis in function space (for example, integration of a function over an ensemble of Brownian paths), (iii) prediction of time series (where prior observation on a sample from an ensemble is used to predict the future), and (iv) the problem of "hidden variables" in quantum mechanics.

All these topics were investigated and illuminated by Norbert Wiener. About ten years ago, a seminar under his guidance at M.I.T. was devoted to this material. The present volume developed from that seminar; some new material, post-1956, has been added. The actual writing was divided up, each author accepting responsibility for certain material, and Rankin was the editor.

My impression is that this book can be read comfortably only if one has command of a rather high level of mathematics. But much of the material in the book should be of great interest to physicists, particularly those working in statistical mechanics and in the foundations of quantum theory. For example, the chapter on prediction of time series is important for certain recent work in non-equilibrium statistical mechanics. The chapter on integration in differential space describes elegant techniques that are now being used to solve specific problems in the statistical mechanical theory of phase transitions.

The book closes with an interesting analysis of the question of hidden variables in quantum mechanics. Is the standard "Copenhagen interpretation" of quantum mechanics, involving use of statistical ensembles, a necessary one, or is it only sufficient? Wiener and Siegel contributed to this discussion by constructing a Brownian motion interpretation of quantum mechanics, in which the individual Brownian path, while not predictable in practice, may be predictable at least in principle. Whether their interpretation is physically significant is presently unclear; but the discussion here sets forth their views clearly.

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Mathematics Made Easier

Lie Groups for Pedestrians. HARRY J. LIPKIN. North-Holland, Amsterdam; Wiley, New York, ed. 2, 1966. 194 pp., illus. $6.50.

The theory of Lie groups has played an increasing role in the development of physics in the last few years. Unfortunately, a large proportion of physicists are insufficiently educated in this mathematical field and tend to regard its machinations with awe and suspicion. Available texts are too formal and often too extensive to assist those who merely want a good idea of how these techniques are applied in physics. *Lie Groups for Pedestrians* is intended for just these people.

The author achieves his aim by adopting an informal pedagogical approach. Rather than presenting formal definitions and derivations, he leans heavily on analogy with the familiar angular momentum algebra, which enables him to stress the physical content of the material and to convince the reader of its simplicity. He begins by outlining the benefits of a group theoretic approach, and retains the interest of the not-too-mathematical reader by interspersing physical applications throughout the book. The material covered is obviously influenced by the author's experience and contains some of his original contributions. As these comprise both nuclear and elementary-particle physics, the book will appeal to, and be appreciated by, people in rather different fields. There is an extensive discussion of the group SU(3), applied to high-energy physics and in