THE FIRST CENTURY OF EXPERIMENTAL PSYCHOLOGY

Edited by
Eliot Hearst

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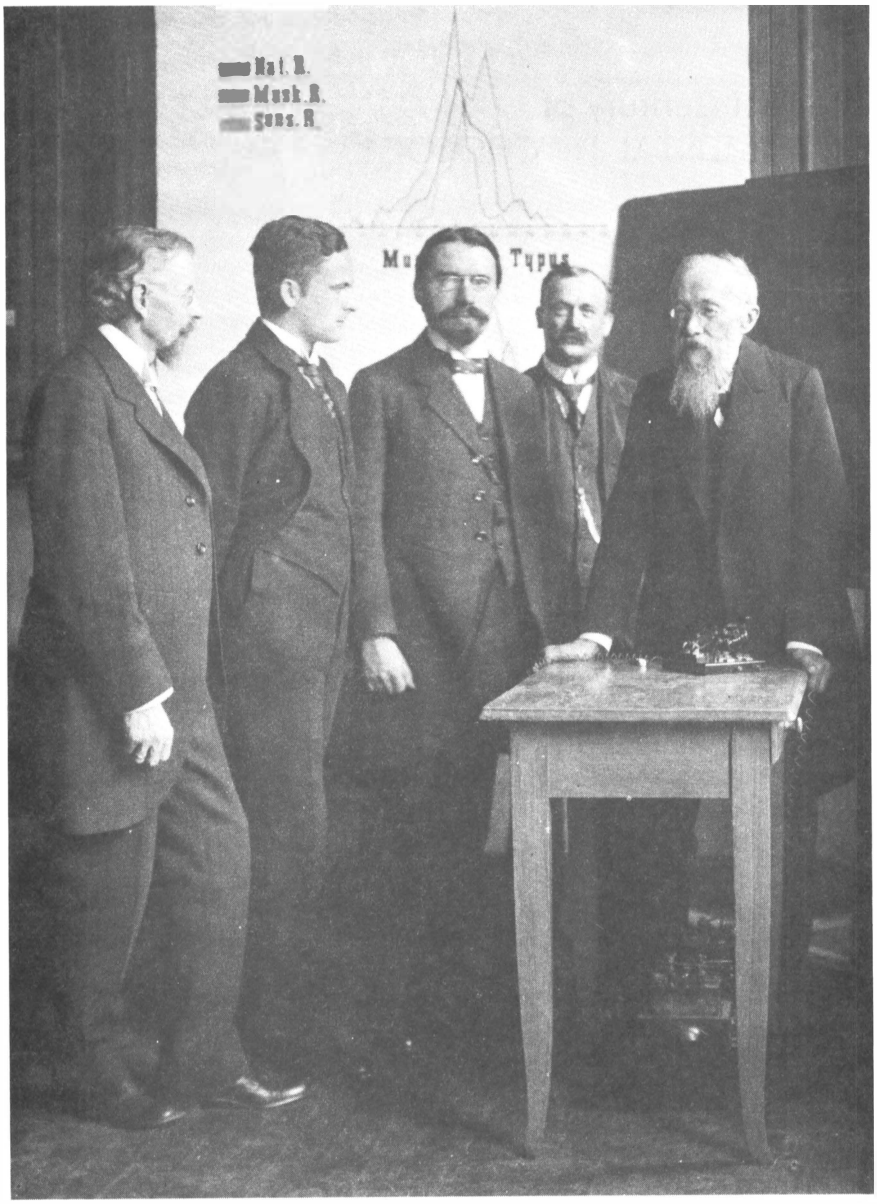

Wilhelm Wundt, at eighty years of age (1912), with his reaction-time equipment. In the picture are (left to right) Ottmar Dittrich, Friedrich Sander, Wilhelm Wirth, Herr Hartmann (a research technician), and Wundt. The photo was generously supplied for this volume by Wolfram Meischner of the Karl-Marx University of Leipzig.

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Edited by
ELIOT HEARST
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Preface

Plans for the celebration of America's Bicentennial in 1976 prompted many individuals and groups to examine their genealogical roots and to survey their present situation in terms of the influence of the past. In what ways are we definitely better off now than decades or centuries ago? Has our development been smooth and logical, or uneven and haphazard? Did certain seemingly unimportant incidents have much greater significance than had been anticipated at the time? Why have some apparently momentous issues almost completely faded from the scene? As professional soul-searchers, psychologists were quite at home in this general atmosphere of retrospection. Besides, there was also a special reason for the arousal of their interest in historical matters—the impending centennial of the opening of Wilhelm Wundt's laboratory at Leipzig, Germany, in 1879. This is the event most frequently recognized as the official beginning of scientific psychology, and it symbolizes the emergence of psychology as a discipline separate from philosophy and physiology.

In the latter part of 1975, a number of North American experimental psychologists began to informally discuss various ways of celebrating and publicizing this anniversary of psychology's declaration of intellectual independence. Several facetious suggestions were immediately offered: colorful fireworks displays at the major psychological conventions of 1979; a few candlelight parades, especially arranged to illustrate Weber's and Fechner's basic laws of psychophysics; the extensive training of a squad of gorillas so that they could communicate in sign language with human beings while simultaneously climbing the Empire State Building. Obviously, such flamboyant types of celebration had to be rejected and replaced by more

constructive, dignified, and permanent kinds of commemorative activities. Most appropriate seemed the preparation of a book, to appear during 1979, in which experts from key areas of the science would summarize and evaluate the early history, later progress, and current status of work in their respective areas. The book would not be composed of dull, pedantic articles packed with technicalities, details of numerous experiments, and obscure theoretical points. It would try to attract and hold the attention of scientists, students, and educated laymen not knowledgeable in experimental psychology, and yet retain appeal for students and specialists in the topics being discussed.

With strong initial encouragement and support from Richard L. Solomon of the University of Pennsylvania and Conrad G. Mueller of Indiana University, I decided to try to organize and edit a volume along these lines, provided the project would be sponsored by the Psychonomic Society and thereby be assured of the participation of high-quality contributors. As someone who has taught a course on the history and systems of modern psychology since 1965, I have discovered that students usually find their acquisition of a historical perspective on psychology more valuable than they expected. They report that it helps them to better organize their thinking about psychology and that it increases their critical understanding of the typical problems and attempts at solutions that concern all psychologists. They also say that they become more tolerant of unorthodox views and more appreciative of the difficulties faced by someone who advocates unconventional ideas. Sometimes students remark that a broad knowledge of the history of experimental psychology aids them in generating ideas, methods, and strategies for their own specialized research.

Furthermore, as an active researcher in several areas of experimental psychology since 1954, I have often been disturbed by the minimal interest that many practicing experimentalists show in the long-term historical background of work in their own and other areas. In my opinion, this lack of knowledge or interest is a primary reason why facts, theories, or approaches that have been described or proposed at various times in the past are often unwittingly "rediscovered" or "reinvented" in the present. It seems to me that research and course requirements in psychology, particularly at the graduate level, are becoming too specialized; and the study of the historical development of even a relatively specific field is now often belittled as irrelevant to the concerns of an active, productive experimentalist. Both these trends seem shortsighted and frequently even harmful. Be that as it may, even if a person were interested in the historical development of various areas of experimental psychology, there is no single volume or set of articles that would provide clear, up-to-date descriptions along these lines. This gap in the literature is one that the proposed volume sought to fill, hopefully in a way that would point up parallels between research and theory in areas that may superficially seem quite far apart. One of our secret hopes was that

researchers with narrow interests might be enticed into reading about developments in areas outside their specialties, merely because such material was collected together conveniently in one volume.

In the spring of 1976, the governing board of the Psychonomic Society voted to sponsor a centennial volume of the kind outlined here and offered its help in deciding on the specific topics for inclusion, in nominating authors, and in reviewing the chapters once they had been submitted. It was particularly appropriate that the Psychonomic Society should associate itself with the project, because its own twentieth anniversary occurs in 1979. Briefly known as the American Federation of Experimental Psychologists after its formation on December 31, 1959, the organization was later convinced by Clifford T. Morgan and William Verplanck that adjectival use of the term *psychonomy*—an already existing word referring to the laws or science of the mind—would provide a more graceful, distinctive, and accurate name for the society. Therefore, this volume also celebrates the vigentennium of the Psychonomic Society, whose membership now numbers more than 2000 research psychologists, each of whom had to publish significant postdoctoral research before he or she was accepted into the group.

Although space limitations would obviously prevent fulfillment of all the criteria that authors were asked to bear in mind, each of the chapters in this book was supposed to include some discussion of: (1) the historical background and development of work in a specific area, covering key events and individuals; (2) the most important experimental findings and methods; (3) the crucial theoretical issues that have influenced and guided experimentation and thought in the field; (4) an evaluation of the contemporary status of the field and its prospects for the future; and (5) where warranted and appropriate, the practical and social relevance of work accomplished so far. Thus, authors were asked not to provide a mere recounting of historical facts; rather, they were encouraged to express their own opinions about past progress and to make some informed predictions about the future, if they were brave enough (or foolish enough) to take advantage of the opportunity. However, strong pressure was placed on the authors to provide a balanced account, not omitting major ideas and movements with which they might personally disagree.

"*Scientific American* style" served as a rough guide for the level of exposition, and consequently the hope was that the volume would appeal to a broad audience and also prove an effective teaching device, suitable as a text or auxiliary book in courses covering history and systems of psychology, introductory experimental psychology, and various specific research areas. Instead of being exhaustive, bibliographical citations were to be kept as selective as possible, serving mainly to provide the reader with references to: (1) the most important original contributions; or (2) easily accessible authoritative reviews and secondary sources containing more specific

information and references. To avoid excessive pedantry and a choppy narrative, page references were required only for lengthy quotations, and books or articles that were mentioned only by title in the text did not have to be included in the reference section. We asked simply that enough information be supplied so that interested readers would have no great difficulty tracking down a reference or quotation.

It took most of 1976 to decide on the specific chapters for inclusion and to nominate and obtain acceptances from persons judged highly qualified to write the chapters. During 1977 and the first half of 1978, Chapters 2 through 13 were written, and then each of them was reviewed by from three to eight experts who were all informed of the general themes of the volume and the specific criteria that authors had been asked to follow. Finally, on the basis of the reviews and the editor's comments, these 12 chapters were revised for publication. The editor tried to prevent undue overlap among different chapters by distributing outlines of most chapters to every author while the first drafts were being composed and, later on, by requesting deletions from certain chapters when material seemed an unnecessary duplication of points raised in other chapters. The editor also had some success in convincing various authors to cover several important topics in experimental psychology that did not fall neatly within the chapter headings selected for the book and that might otherwise have been omitted completely. For each chapter, the final product represents some compromise among the author's freedom of choice and expression, important points raised in the reviewers' criticisms, adherence to the criteria proposed for the volume, and space limitations. The introductory chapter (Chapter 1) and final overview (Chapter 14) were completed after drafts of all the other manuscripts were available, so that these two chapters could discuss broad issues and yet refer to individual chapters for examples.

Of course, the success of any volume of this kind depends almost exclusively on the quality of the authors' individual contributions. Nevertheless, many other people played an important role in the initial conceptualization, final content, and overall production of the book. Harold W. Hake, Arthur W. Melton, Conrad G. Mueller, Richard L. Solomon, and Endel Tulving provided encouragement and advice at various crucial stages of the project. The publisher, Larry Erlbaum, was as enthusiastic, helpful, prompt, and devoted to the book as any editor or author could desire. The production editor at LEA, Ros Herion, displayed remarkable patience, thoroughness, geniality, and support, which I greatly appreciate. The atmosphere at Indiana University's psychology department was virtually ideal for this venture; its facilities and those of the university library are excellent. The departmental chairman, Irving J. Saltzman, was very supportive and even reduced my teaching load during the spring semester of 1978 so that I could devote additional time to the volume. My research

associate and friend for many years, Dexter Gormley, deserves special thanks for assistance in connection with many technical details of the project; his aid often went far beyond what I could reasonably have expected. It was he who transformed a disorganized collection of photographs of varying excellence, shade, and size into the nicely arranged sets of trim pictures that are distributed throughout the book. Among other undergraduate and graduate students, Sarah Bottjer, James Capshew, Peter Kaplan, Eileen Riffe, Edward Walker, and especially Louise Martin made valuable specific contributions during the processing of the volume.

Fellow faculty members at Indiana gave freely and generously of their time—making suggestions about the format and content of the book in its early stages, reviewing drafts of various chapters, and helping me to find nonspecialists on whom to "test" the clarity and comprehensibility of the submitted chapters. Especially energetic as reviewers were Jeffrey Alberts, James Allison, Richard Aslin, Alexander Buchwald, Douglas Ellson, Gabriel Frommer, George Heise, Steven J. Sherman, Richard Shiffrin, Linda Smith, and William Timberlake. Several secretaries provided expert assistance during the 3 years consumed by the project, of whom Carol Daniels Smith handled a major portion of the task, always with dedication and good humor.

A large debt is due the more than 50 people who interrupted their own work to read the various chapters and supply reviews and comments about them. A good number of these reviewers treated the project almost as seriously as the authors did, and some of the commentators' critiques would themselves probably be worthy of publication. With the exception of a few individuals who preferred to remain anonymous, the following persons acted as outside reviewers of one or more chapters in the book: John R. Anderson, Fred Attneave, Frank A. Beach, Daryl J. Bem, Arthur L. Benton, Robert Boice, Robert Boynton, Byron Campbell, Douglas Candland, George Collier, Robert Crowder, Michael D'Amato, Kurt Danziger, Leonard D. Eron, John H. Flavell, Wendell R. Garner, Russell Geen, Henry Gleitman, Anthony Greenwald, Norman Guttman, Willard W. Hartup, Donald O. Hebb, Edna Heidbreder, J. McVicker Hunt, Carroll Izard, Lloyd Kaufman, William Kessen, Richard S. Lazarus, Robert Leeper, Donald B. Lindsley, Lewis P. Lipsitt, William A. Mason, Judson Mills, Gardner Murphy, David S. Palermo, Irwin Pollack, Karl H. Pribram, Robert Rescorla, Mark R. Rosenzweig, Robert R. Sears, David Shakow, Linda Siegel, Norman Slamecka, John A. Stern, Endel Tulving, Benton J. Underwood, Elliot S.Valenstein, Robert I. Watson, Michael Wertheimer, and Joseph Zubin. Of course these men and women are in no way accountable for any errors or omissions that remain in the volume, but they certainly influenced the content and style of the final products.

Special recognition must go to the anonymous person who generously agreed to contribute to the Psychonomic Society a sum equal to the

publisher's profits from this volume. This was an unexpected bonus for the society because it had agreed to sponsor the project long before this benefactor appeared.

We realize that our decision to include photographs of important contributors to the history of experimental psychology is controversial for a variety of reasons. However, the photographs seemed appropriate for a commemorative volume, and we thought that their inclusion would aid students in associating certain names and dates and in obtaining an overview of the chronology of developments in various areas—because relevant individuals have been arranged in sequence, according to their birthdate, after each chapter. A large number of the individuals influenced more than one area of experimental psychology, and they could justifiably have been placed after several different chapters; their actual placement was often determined by our attempts to establish some kind of balanced arrangement and regular distribution of the photographs in multiples of four throughout the book. Therefore, individuals do not necessarily appear after discussion of the area to which they made their greatest contributions. Because the first few chapters in the book cover topics that attracted appreciable attention relatively early in the history of experimental psychology, there are proportionately more photographs in that part of the volume.

Selection of the people to include in the photograph sections was of course neither a simple nor a completely objective task. The choice of individuals was based on a combination of criteria: nomination by authors of the respective chapters; frequent references in this book to the person's contributions; high scores with respect to the person's importance in the history of psychology, according to the ratings published in Annin, Boring, and Watson's 1968 article in the *Journal of the History of the Behavioral Sciences;* the winning of a Nobel Prize or an American Psychological Association Award for Distinguished Scientific Contributions; recommendations from colleagues in various areas of experimental psychology; and so on. Because it is so difficult to assess the historical significance of the work of relatively young individuals, everyone whose photograph appears in this book had to be either deceased or more than 60 years old—with two exceptions, justified strongly by their undebatable contributions to a late burgeoning field, experimental social psychology. The selected persons did not necessarily have to live in the period between 1879 and 1979, nor did they have to be experimentalists or even psychologists, as long as their theories or views are generally agreed to have had a significant and strong influence on the development of one or several areas of experimental psychology. Unfortunately, the inclusion or omission of particular individuals will doubtless irritate a number of readers; we apologize in advance if we have made any serious mistakes in judgment. Collection of the photographs—some of which have never, to our knowledge, appeared before in print—was an enjoyable task, and we believe they add

something unusual and valuable to the book. An alphabetical list of the selected individuals is given on pp. xiii–xvi, along with the donor or copyright holder for each photograph. We thank all these sources for their permission to reproduce the photographs.

An editor cannot be denied the opportunity to insert into his preface a few personal acknowledgments. My wife, Marion, and three young children, Jennifer, Andrew, and Nicola, provided a combination of love, cooperation, distraction, and occasional pandemonium that, taken as a Gestalt, enriched my efforts on the volume. My father, John Hearst, and my sister, Marlys H. Witte, contributed help to several aspects of the venture. Finally, I would like to dedicate my part of the work on this book to the memory of my mother, Frederica Hearst, who died unexpectedly while the volume was being completed. My most influential teacher, she tried her best to transfer to me her own thirst for knowledge, her vigorous belief in the value of a broad education, and her capacity and love for independent and hard intellectual study. Without her sacrifices and encouragement, my education would probably not have progressed very far. I wish she could have read this book. Although not a psychologist, she was looking forward enthusiastically to studying it and learning from it.

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The First Century of EXPERIMENTAL PSYCHOLOGY

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1 One Hundred Years: Themes and Perspectives

Eliot Hearst
Indiana University

I. INTRODUCTION

One of the first times that William James mentioned his growing belief that psychology could be a science was in a letter he wrote from Germany in 1867 to his friend Thomas Ward. James was then 25 years old.

> It seems to me that perhaps the time has come for psychology to begin to be a science—some measurements have already been made in the region lying between the physical changes in the nerves and the appearance of consciousness ... (in the shape of sense perceptions), and more may come of it. I am going on to study what is already known, and perhaps may be able to do some work at it. Helmholtz and a man named Wundt at Heidelberg are working at it [James, 1920, pp. 118–119].

Twenty-five years later, James had extensively "studied what is known," and had completed his monumental two-volume textbook, *The Principles of Psychology* (1890). Many psychological laboratories and institutes had opened in Europe and America. However, sad to say, James was not particularly enthusiastic about the development of psychology as a natural science. In the short version of *Principles* (1892) he described the "New Psychology" as follows:

> A string of raw facts; a little gossip and wrangle about opinions; a little classification and generalization on the mere descriptive level; a strong prejudice that we *have* states of mind, and that our brain conditions them: but not a single law in the sense in which physics shows us laws, not a single

> proposition from which any consequence can causally be deduced. We don't even know the terms between which the elementary laws would obtain if we had them. This is no science, it is only the hope of a science.... Something definite happens when to a certain brain-state a certain "sciousness" corresponds. A genuine glimpse into what it is would be *the* scientific achievement, before which all past achievements would pale. But at present psychology is in the condition of physics before Galileo and the laws of motion, of chemistry before Lavoisier and the notion that mass is preserved in all reactions. The Galileo and the Lavoisier of psychology will be famous men indeed when they come, as come they some day surely will, or past successes are no index to the future.... Meanwhile the best way in which we can facilitate their advent is to understand how great is the darkness in which we grope, and never to forget that the natural-science assumptions with which we started are provisional and revisable things [p. 468].

One of the main goals of this book is to summarize and assess the major findings and theories that have accumulated since psychology was self-consciously declared an independent, experimental discipline in the 1870s. Many solid and provocative results will be presented that would undoubtedly have impressed and delighted James, even in his most critical moments. We can now point with pride to some well-established functions and laws enabling fairly precise quantitative predictions in diverse areas of psychological science (see Estes, Chapter 14). Clear progress has been made concerning the physiological bases for certain sensory and perceptual processes and for some very specific aspects of motivation, emotion, memory, and attention. Numerous practical applications of laboratory results have been developed and are now a part of the technology of the late twentieth century.

Despite the undeniable accomplishments that appear in the pages of this volume, we will also encounter "wrangles about opinions," bits of "gossip," and a variety of "strong prejudices"—all expressed since James offered his unenthusiastic evaluation of scientific psychology near the end of the nineteenth century. Although some experimentalists working on topics in fields related to psychology have won Nobel Prizes for their contributions, the Galileo or Lavoisier of psychology has failed to materialize: No one has successfully proposed any principle or general framework that serves to unify or encompass many different areas of scientific psychology. In fact, a large number of contemporary experimental psychologists seriously doubt whether psychology is a field that will ever see the emergence of truly global principles of the kind that Galileo or Lavoisier identified or that Darwin bequeathed to biology. Because we still grope in the darkness about so many aspects of behavior, perception, and cognition, bands of skeptics today contend that the scientific approach to psychology has failed to meet reasonable standards of progress in the 100 years it has had to prove itself.

Therefore, not everyone agrees with Boring's opinion that "the application of the experimental method to the problem of mind is the great outstanding event in the history of the study of mind, an event to which no other is comparable," or with G. Stanley Hall's almost religious faith that scientific research, whether in psychology or other fields, is a "sacred quest." Devotion to pure science would inevitably produce valuable practical results, Hall believed; understand the basic principles and "their applications are relatively easily and quickly learned (see Ross, 1972)."

If this book achieves its stated goals, readers should be able to decide for themselves how successful experimental psychology has been in its first century and what its prospects are for future valuable contributions to mankind's scientific knowledge, self-understanding, and technology. On these questions, none of our authors is either a total optimist or a dire pessimist. All of them would agree, I think, that significant advances have occurred but that the challenges are as great as ever. The potential discoveries and benefits appear worth the inevitable trips up blind alleys, the "blank" periods or plateaus when little progress is apparently being made, and the time occasionally spent justifying to others the value of basic research in psychology.

This introductory chapter is intended to set the stage for the historical reviews and assessments of work in specific areas that constitute most of the book. Especially directed at nonpsychologists and students in the field, the chapter presents a brief panorama of the early history of experimental psychology—some of its antecedents, its most influential "schools" or systems and their beliefs—and accentuates several themes and issues that will repeatedly arise in subsequent chapters. Before that, however, some general comments seem appropriate concerning the scope and assumptions of experimental psychology and the value of knowing something about its history.

II. EXPERIMENTAL PSYCHOLOGY: ITS SCOPE AND ASSUMPTIONS

One hundred years ago, only a handful of people in the world held a Ph. D. in psychology,[1] and G. Stanley Hall had just received the first one awarded in America (see Cairns & Ornstein, Chapter 11, this volume). No one was a professor of psychology, and there were no institutions that offered undergraduate majors in the subject. Nowadays, each year finds a quarter of a

[1]Readers interested in the origin and evolution of the word "psychology," and its first users, should consult Lapointe (1970, 1972).

million American students majoring in psychology (see McKeachie, 1976), most of whom read about or actually receive explicit training in experimental methods as applied to many different subareas of the discipline. There are more than 5,000 scientists who have received doctoral degrees in various fields of experimental psychology and perform basic research in their particular specialties. Scores of journals are published that cover material of general and specific relevance for scientific psychologists.

Experimental psychologists now work on a large variety of topics, including the study of vision, audition, and touch—areas already popular in the psychophysical investigations of 1879. Some contemporary workers test the memory of children and adults for different prose passages, and others analyze the reaction times of humans and pigeons as they search rapidly for a specific symbol in an array containing many different symbols. There are researchers who examine in various social contexts the effects of drugs that produce physiological reactions like those typically present during certain emotions in humans. Scientists working with animals investigate the ease of establishing associations between unusual tastes or smells and subsequent gastrointestinal illness, or they compare methods for removing learned fear responses. Experts in "animal behavior" study the persistent tendency of ducklings to follow a moving object that they were exposed to (imprinted on) during the first day of their lives. Experimental social psychologists analyze the facilitation or suppression of a college student's performance depending on whether or not other people are present, or examine the factors that make human beings obey an instruction or conform to judgments that they might have been expected to defy. Researchers are performing exciting work revealing the abilities of chimpanzees to learn a variety of "languages" constructed by human beings. Physiological psychologists study electrical changes occurring in the brain during presentation of various external signals and the effects of chemical stimulation of specific parts of a rat's hypothalamus on its eating and drinking behavior. Experimental psychopathologists compare schizophrenics with other groups of patients in terms of the details of their linguistic output, distractibility, or logical reasoning. Other psychologists focus on such diverse topics as possible genetic bases for maze learning in fruit flies and the apathy or depression shown by "helpless" human and animal subjects that cannot control the occurrence of various important environmental events.

As in any science, relatively sophisticated instrumentation is an important part of the experimental psychologist's arsenal, not only to precisely control and change certain aspects of the environment, but also to enable reliable recording and timing of the subject's responses. Revolving memory drums or electronic displays present words for human subjects to memorize, and devices called tachistoscopes flash to-be-recognized words or letters on a screen for a small fraction of a second. Tiny electrodes are attached to single

cells in the brain or other parts of the visual system of cats to record their responses to various orientations of a line or directions of its movement. Both massive and miniature computers program the presentation of complex stimuli and simultaneously collect and analyze the subject's responses. Infant monkeys share cages with surrogate "mothers" made out of cloth or wire. Experimental settings have been constructed to study the operant conditioning of subjects varying in size from goldfish and honey bees to elephants and dolphins. When building theories or just planning future experiments, experimentalists often range far from conventional psychology in their search for suitable quantitative techniques and model systems. The use of procedures or frameworks adapted from mathematics, computer science, or physics is not at all rare.

Thus we see that experimental methods are applied in almost every sphere of psychology and have not been limited only to special types of organisms, kinds of behaviors, and sorts of situations. Of course, the historical reviews in this book will demonstrate that particular men had very narrow views about what constitute permissible and appropriate environments, organisms, topics, or responses for experimental psychology to study. However, those who have considered themselves experimental psychologists generally share certain basic beliefs and follow certain basic procedures or strategies that differ from the methods employed not only by the "mental philosophers" who studied the mind and its contents long before the advent of the "new" psychology, but also by contemporary philosophical analyses of the mind. The pre-experimental students of the mind based their conclusions and speculations almost exclusively on introspection, on reasoning from their own past individual experiences, and on their knowledge of the experiences, observations, and writings of other human beings.

In place of this kind of approach—which of course led to important, though often not easily verifiable, insights about principles of psychology—the experimentalist, typically a believer in the methodological unity of all the sciences, demanded actual investigations conducted in a well-controlled environment arranged to yield concrete, recordable responses from a subject. In most cases the ideal experiment was conceived to be one involving the method of "varied conditions," in which all the factors except for the one or two variables systematically manipulated by the experimenter—the independent variables—were held constant while the subject's reactions (the dependent variables) were observed or measured or transcribed. Over the history of experimental psychology the subjects' reactions have ranged from lengthy verbal introspections supplied by well-practiced subjects describing their conscious experience during presentation or manipulation of certain external stimuli, to more objectively measurable and more easily quantifiable actions such as simple "Yes–No" answers, depressions of a key or switch, reflex knee jerks or eye blinks, correct or incorrect entries made by a rat into

the sectors of a maze, words recalled from a list shown to the subject minutes or hours before, and sequences of group members' verbal statements to the other people present in a social situation.

In the early days of the new psychology, William James and some of his colleagues spoke disparagingly of the "brass-instruments" and simple "curves and graphs" its practitioners used, with the implication that technical matters captured too much of their attention and pride. According to the critics, these experimentalists were investigating relatively minor, even "boring" topics in artificial, unnatural situations, instead of concentrating on the formulation and examination of significant psychological questions and on the search for universal, general laws that epitomize a mature science. Later in the history of experimental psychology, and even today, we hear similar complaints. Some psychologists are described as method- rather than problem-oriented: Their research is said to focus mainly on the extensive, relatively nontheoretical analysis of a specific, well-accepted methodology—for example, the variables affecting a pigeon's key-pecking behavior in a Skinner Box, the numerous factors controlling serial learning of unrelated words or syllables presented on a memory drum, or the effects of various procedural details on children's performance of a task devised by Jean Piaget. In such cases, study of the "method" seems almost to become an end in itself; virtually forgotten may be the need for relating the research to significant problems for psychology. With justification, one can argue that a generally preferable strategy would include experiments in which different theoretical mechanisms or alternative explanations are pitted against each other and, by appropriate design, "resolved" in favor of one or the other. Although basic and indispensable, the validation or collection of mere facts and observations is not the ultimate goal of science; as Charles Darwin remarked, science consists of grouping or organizing facts so that general laws or conclusions may be drawn from them.

The experimental psychologist's confidence in the definite value of controlled observation, careful manipulation of independent variables, and, most important, the search for "causal" explanations and general laws has usually been accompanied by the assumption or faith that not only simple or basic psychological processes like sensory discrimination can be profitably studied in the laboratory, but also a great variety of other topics—ones that critics might argue cannot be brought into a laboratory without establishing conditions so contrived and unnatural that the results would be virtually useless. The skeptics would say, for example, that a monkey placed in a barren chamber, where it must choose between lifting a circular or a square block to obtain food pellets, is being studied in a situation resembling none that it would encounter in real life, just as is the case for a human subject recalling lists of unrelated words on index cards or bargaining with others in a laboratory setting designed to simulate the conditions under which real-life executives must reach difficult decisions. Others who are dissatisfied with an

experimental approach to psychological problems insist that the phenomena of psychology are determined by so many interacting factors that experimental isolation of the crucial ones is virtually impossible; and, even when the approach is seemingly successful, the final conclusions may be strongly lacking in generalizability to new situations. In addition, as Estes (Chapter 14) points out, organisms are continually in a state of change as their lives progress, and the steady-state conditions that other sciences often can achieve appear difficult, if not impossible to obtain for many psychological problems. Thus, the argument goes, much experimentation may merely add up to an academic exercise.

These paradigmatic objections to experimental psychology—as well as either reasonable or rash complaints about the ethics of certain kinds of experimentation, and vaguer criticisms such as "science misses the central reality of human nature and life itself" because science is necessarily deterministic—are about as old as experimental psychology itself. At least we no longer have to rebut several of the accusations hurled at experimental psychologists of the nineteenth century. Some German academicians, besides thinking experimental psychology a temporary fad, opposed the work done with well-practiced human subjects in Wundt's laboratory because they believed that excessive examination of the mind could cause insanity. And Cambridge University refused to permit the establishment of a psychophysics laboratory because study of such a topic would "insult religion by putting the human soul on a pair of scales."

In the long run, the success of experimental psychology itself, and the validity of the more reasonable general objections to its value—the supposed artificiality of its testing situations and the related question of the potential applicability of its results to natural environmental settings, and the problems created by the multiple causation that seems inherent in even relatively simple types of psychological phenomena—will be assessed not by such things as lists of the amount of work accomplished by its practitioners or counts of the number of students interested in the topic. The success of experimental psychology will depend on the actual achievements of psychological scientists in telling us things we did not know before, in discovering precise laws and functions that govern a variety of different situations, in formulating theories or models that explain more than just a limited set of data or phenomena and that are useful in directing research, in demonstrating the relations of psychological mechanisms to physiological and other biological mechanisms, in mapping the psychological capacities and limitations of animals and humans, and in devising practical suggestions that can be implemented for society's benefit. In several respects these criteria match those that any successful science must eventually fulfill. Furthermore, all experimental disciplines, from physics to physiology, have to employ more or less "artificial" situations or "preparations" to obtain their basic data. And,

at least in its infancy, every science must have presented problems of apparently overwhelming complexity due to the host of factors that seemed to play a causative role. Experimental psychology can be regarded as a set of general methods for attacking certain problems, resembling the strategies used in other sciences, rather than as a separate topic for psychologists to study.

III. THE WRITING AND STUDY OF THE HISTORY OF EXPERIMENTAL PSYCHOLOGY

Few practicing experimental psychologists have received more than a superficial exposure to the history of psychology during the course of their academic training, and even fewer develop an interest in historical matters as their research careers proceed. The planning of new experiments, the analysis and public communication of the results, and the reading required to keep up with the doings of other contemporary researchers consume large amounts of time—in addition to the hours most scientists devote to their teaching and administrative responsibilities. Therefore immersion in the history of their own particular field, let alone the history of general experimental psychology, seldom ranks high on their list of priorities. The contributors to the *Journal of the History of the Behavioral Sciences*, which began publication in 1965, are rarely productive experimentalists, and the number of members of the American Psychological Association's Division 3 (Experimental Psychology) who are also members of Division 26 (History of Psychology) is not very substantial. Therefore, in a sense this book represents an unusual "experiment," because the authors are influential and productive experimentalists who were willing to take the time to research and write a "historical" chapter. It will be interesting to see whether their efforts meet with the approval of psychologists whose major contributions and pursuits lie specifically in the history of psychology. Possibly, a book like the present one will help to bring the two groups closer together—to fight or to collaborate.

There are various ways to write a history of a particular scientific field. One general approach would derive from the so-called Great Man theory of history and would emphasize relevant biographical details of the lives of major contributors to the field—specific events that influenced their choice of careers and research topics as well as the development of their thinking; the identity of their universities, teachers, and students; their own most important findings and theories. An alternative general approach would minimize the role of individual scientists and the recitation of facts about them, and would stress the evolution and interpretation of various themes, ideas, and issues; it would analyze how and why different points of view developed, and it would examine the type, quantity, and quality of research that was performed and

the specific theories that were dominant at particular times. The Zeitgeist—the intellectual or cultural climate prevailing when a finding or theory is initially presented—would be discussed as an important determinant of the willingness of other scientists and the general public to accept or reject the finding or theory. If successful, both approaches to the history of a field would probably enable discriminating readers to detect instances when scientific progress seemed to involve a slow, cumulative process—ideas building clearly on prior knowledge, famous people standing on the shoulders of their immediate predecessors and teachers—as well as instances when a particular influential finding or approach was revolutionary rather than just evolutionary. Most contributors to this volume opted for an approach stressing issues, themes, and general developments, but important names, interesting biographical details, and significant specific events are mentioned when appropriate.

Reflecting the recent increased interest in historical matters, numerous articles have appeared within the past 10 to 20 years that enumerate reasons why specific study of the history of psychology merits considerable attention. Besides its intrinsic appeal for the intellectually curious, a knowledge of the history of psychology has been said: (1) to enable us to avoid certain traps into which past researchers or theorists have fallen; (2) to help us recognize that "new" facts and theories may really be old ones in disguise; (3) to highlight for us the uncertainty or tentativeness of scientific conclusions and the revisions that inevitably become necessary, thus teaching us to view our own theories and conclusions with humility and the opinion of others with tolerance; (4) to allow us to better judge the rate of current progress and the significance of contemporary approaches, by comparison to past developments and proposals; (5) to show us how various divergent trends or subject-matter areas in psychology have been or may be integrated into a more unified framework; (6) to serve a heuristic function—as a source of new ideas, methods, and hypotheses for our own work; (7) to reveal to us how amazingly powerful a simple but original idea can be and perhaps to suggest novel ways of assessing the testability and generality of such an idea; (8) to promote our understanding of the relationships between the particular field whose history we are studying and other fields of psychology, different scientific disciplines, and various sociocultural problems; (9) to provide us with fresh examples of phenomena to replace or clarify the more conventional ones that always leap immediately to our minds; and (10) much more questionable than the other justifications, to help us "predict" or at least plan intelligently for future trends in a particular area or over the entire discipline of psychology.

We are told by many writers of history that study of the habits and personalities of great scientists can inspire and edify us. For example, their success was not immediate; they generally suffered numerous frustrations as well as rewards, and therefore dedication, courage, and patience were

required; they found science a tremendously exciting endeavor. We learn that commitment to a particular point of view may greatly prejudice a person's experimental observations and blind him or her to the existence and implications of contrary data, to reasonable alternative explanations of the results, to weaknesses in the person's own theory, and to the potential advantages of new views. Nevertheless, commitment is desirable and virtually unavoidable in a good scientist, and no one said it better than William James (1897):

> Science would be far less advanced than she is if the passionate desires of individuals to get their own faiths confirmed had been kept out of the game.... If you want an absolute duffer in an investigation... take the man who has no interest whatever in its results: he is the warranted incapable, the positive fool. The most useful investigator... is always he whose eager interest on one side of the question is balanced by an equally keen nervousness lest he become deceived [p. 21].

If the foregoing justifications for studying the history of psychology were as powerful and well established as their proponents insist, then it would almost seem that experimentalists should devote equal time to carrying out research and studying the history of their own and allied areas. Not many researchers would ever agree to such a division of their labors! However, within the pages of this book is found support for most of the preceding justifications. Of particular interest to contemporary workers, I think, will be examples of how certain methods, theories, or approaches to research that are prevalent in 1979 were either clearly anticipated or specifically proposed and tested many years ago in writings unfamiliar to a good number of today's experimental psychologists. For instance, Cairns and Ornstein (Chapter 11, this volume) show how numerous aspects of Piaget's basic theory of cognitive development can be specifically traced back to views presented in detail by his predecessor, James Mark Baldwin, an important thinker though little remembered and studied today. Cairns and Ornstein also point out how present-day work concerning the representation of meaning in memory and its relation to human processing limitations was clearly anticipated in research performed by Alfred Binet at the turn of the century; it took us 70 years "to catch up with Binet's insights." In a more familiar case, Posner and Shulman (Chapter 9, this volume) describe the current popularity of a reaction time method that Franciscus Donders invented around 1865 to calculate the speed of mental operations or stages—a method adapted and frequently employed in Wundt's laboratory, only to be abandoned in the early twentieth century because of the unsuccessful way Wundt had attempted to incorporate it into his general system and because the behaviorists were horrified at the very idea of measuring mental operations.

In addition to examples of the reappearance or rediscovery of an old method or idea that are presented in this book, Blumenthal (1977) furnishes some others: Sperling's (1960) widely used "partial report" method for studying memory of arrays of briefly presented letters was inspired to some extent by similar procedures that were used in Wundt's laboratory in 1899; Miller's (1956) "Magical Number 7 ± 2" for characterizing the capacity of human short-term memory was discussed in analogous fashion and experimented upon by W. S. Jevons in 1871 and others in the late nineteenth century; the popular Peterson and Peterson (1959) technique for studying very rapid forgetting in humans is not much different from a method employed by A. Daniels in 1895. And recently the *Journal of Experimental Psychology: Human Learning and Memory*, in an article by Stigler (1978), reprinted accounts of the quantitative experimental studies on human memory performed in 1876 and 1878 by an American physicist, Francis Nipher. This work predated the publication of Ebbinghaus' classic book on the subject by 9 years (see Cofer, Chapter 8) and, although of only small magnitude compared to Ebbinghaus' contribution, has been overlooked by historians of psychology.

It is heartening to learn that even though these early experimenters possessed neither the sophisticated apparatus and automatic data-processing and experimental-programming techniques of today's laboratories, nor abundant stimulation from groups of colleagues working on related topics, they were still able to perform excellent work and in some cases to develop theoretical interpretations that are of considerable contemporary significance. Certainly, exploring the early history of one's research area does not inevitably lead a person to dull, sloppy, or antiquated experiments. In fact, sometimes it directs us to important articles that are much better written and livelier than those appearing in today's journals and books.

IV. SOME HISTORICAL PERSPECTIVES

Because it is the science that attempts to investigate and ultimately to explain behavior and experience, one could argue that an adequate description of the antecedents and foundations of contemporary experimental psychology must embrace the entire history of mankind and the animal kingdom, and take into account any topics that are directly or indirectly related to these global themes. Such a task will be left where it belongs—to encyclopedists who devote lifetimes to endeavors of that sort and who must enlist the help of thousands of special experts. In this chapter I can only sketch several aspects of seventeenth- to nineteenth-century thought and research that contributed to the establishment of an experimental psychology in the 1870s, briefly describe some events and individuals involved in the founding of this "New

Psychology," and take a quick look at the basic beliefs and methodologies of the various "schools" or systems of the first decades of the twentieth century—whose assertions and disagreements provided some of the sparks that kindled the interest of many students, as well as the general public, in the field of scientific psychology. Although these schools have more or less vanished from the contemporary scene, many of the issues and controversies they highlighted are still with us. In view of the limited coverage possible here, interested readers will want also to consult such standard textbooks as Boring (1950), Heidbreder (1933), Keller (1973), Marx and Hillix (1973), Murphy and Kovach (1972), Wertheimer (1970), and Woodworth and Sheehan (1964), in addition to the material provided in other chapters of this centennial volume.[2]

A. Routes into Modern Experimental Psychology

Although the origins of experimental psychology in philosophy and physiology are usually the two lines of descent emphasized in textbook descriptions of the historical foundations of the field, work in other biological sciences, clinical medicine, astronomy, mathematics, and statistics also provided important sources of knowledge or methodology for the development of the field. The remarkable scientific discoveries made in the seventeenth to nineteenth centuries supplied great inspiration and impetus to those who originally contemplated the prospect of an experimental psychology and who set out to adapt for psychological problems the methods, techniques, and procedures of chemistry, physics, and biology. Even though in the mid-nineteenth century it was already impossible for any single individual to have mastered all the different areas of science and philosophy, the erudition and broad interests of most of the founders of experimental psychology should still merit our admiration, and can be contrasted with the extreme specialization characteristic of many experimental psychologists today.

1. Philosophy. In the two or three centuries before psychology was declared a separate discipline, the authoritative figures in the analysis of the mind were of course philosophers. Before the 1860s psychology was almost universally considered a part of philosophy, not of science.

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[2]Because this book is organized in terms of specific research areas, it tends to neglect certain aspects of the history and current status of experimental psychology that would probably have received attention if the book had been structured in another way. One of these aspects concerns geographical and national differences in research emphases and scope. For discussions of experimental psychology in various countries around the world, see Marx and Hillix (1973) and Sexton and Misiak (1976).

In the history of science in general and of psychology in particular, René Descartes (1596–1650) played an important role as a liberalizing force that resisted classical Aristotelian dogmas and their slavish dependence on tradition and authority. His extensive discussions of the mind–body problem, and his belief that much of the behavior of Man and all the behavior of animals were controlled by physical, machine-like laws, contributed to the eventual development of a scientific approach to behavior and experience. Furthermore, he proposed a physiological theory of how external stimulation leads to bodily response—a theory that clearly anticipated later conceptions of reflex action, although it was incorrect in many details (e.g., he believed that the nerves mediating movements were like hollow tubes through which animal spirits flowed into the appropriate muscles). However, he maintained that Man and only Man had a mind or soul, which, controlled by Free Will and operating through the pineal gland in the center of the brain, could exert powerful effects on bodily mechanisms. This dualistic view was opposed by later, more materialistic philosophers and scientists who believed that it was not necessary to assume a mind–body distinction or to go beyond physical–chemical processes in explaining *all* the actions of both men and animals. Concerning another important point, Descartes claimed that certain ideas are innate (e.g., the ideas of God and the self; the axioms of geometry); they do not arise out of our individual experiences with the external world, but are part of our heritage at birth. Thus, although affirming a distinction between mental and bodily processes in man, Descartes influenced the views of the educated public in the direction of more mechanistic and materialistic interpretations, offered a reductionistic (physiological) reflex-like theory of simple stimulus–response connections, and stressed his (nativistic) belief that certain of our ideas are innately given (see also Littman, Chapter 2, and Thompson & Robinson, Chapter 10, this volume).

The British associationist–empiricist philosophers of the seventeenth to nineteenth centuries (e.g., Thomas Hobbes, John Locke, George Berkeley, David Hume, David Hartley, James Mill, John Stuart Mill, Thomas Brown) were also interested in epistemological questions (the origin, nature, and limits of knowledge). They stressed sensation and association as the basic mental processes and, as the word "empiricist" implies, disagreed with Descartes about the possibility of innate ideas. Their basic belief was that all our knowledge and ideas can ultimately be traced back to sensory experiences with the external world; complex ideas (like pride or liberty) that are not directly sensed develop from the association of simpler ideas. Locke, for example, considered the infant mind at birth to be virtually a blank tablet on which experience (sensation and association) writes. This group of philosophers proposed certain primary rules or laws, similar to those of Aristotle, that controlled the formation of associations between ideas or events. *Contiguity* of such elements (i.e., their temporal or spatial proximity)

was usually emphasized, but *similarity* and *contrast* between elements were also thought to promote the formation of associations, as did various secondary factors (see Cofer, Chapter 8, this volume).

Relying on keen introspection and reasoning, the empiricist philosophers attempted to determine the contents of the mind—those aspects or concepts that are simple and unanalyzable and those that are apparently compounded from the unanalyzable ideas or elements. A distinction between sensations (or impressions) and ideas was proposed by Hume, for which a physiological explanation in terms of vibrations in the nervous system was later developed by Hartley. These men were distinguishing between the immediate effects of the presentation of some definite external stimulation and the "faint copies" of such experiences that occur at a later time, in the absence of the appropriate external stimulus—like the difference between actually seeing someone and visualizing or thinking about that person later on. An analogy to chemical mechanisms or phenomena arose within the context of discussions of the association of ideas; John Stuart Mill, for example, argued in the 1840s that many complex ideas should not be said to "consist of" simpler ideas, but rather to "result from" or "be generated by" the simpler ideas. "These are cases of mental chemistry: in which it is possible to say that the simple ideas generate, rather than that they compose, the complex ones." Thus the properties and laws governing a compound idea may not be predictable from the properties and laws governing its elements; presumably experiment and observation are necessary to determine whether or not this is true. Arguments over the validity and appropriateness of this chemical analogy have, in one form or another, continued to divide psychologists.

We can see in the proposals of these nonexperimental empiricist–associationists the seeds of many issues that characterized or separated experimental psychologists in later years: the comparative importance of nature vs. nurture; the relative validity of "atomistic" vs. more molar (holistic) approaches to analyzing the contents of the mind; the potential value and essence of the distinction between sensations and images; the applicability of physiological reductionism; the explanatory utility of the various laws of association. Not only the analytical approach of Titchenerian structuralists, in their search for the elements of the mind, but also stimulus–response (S–R) associationism and early learning theory—as well as the Gestaltist's holistic approach—have some basic features or aspects that correspond to principles or issues raised by these philosophers of the mind.

The important influence of Immanuel Kant, Johann Herbart, and their philosophical supporters and adversaries in Germany and elsewhere, as well as the significance for psychology of several other contributions from philosophy, are discussed in some detail by Littman (Chapter 2, this volume) and Thompson and Robinson (Chapter 10, this volume). These authors add

examples to the ones I have mentioned to illustrate the great importance of philosophical thought as a background for the emergence of the new psychology.

2. Physiology and Anatomy. The advances made in astronomy and physics by seventeenth-century scientists helped to weaken the power of prevailing cultural and theological dogma and thus encouraged scientific work in physiology and anatomy as well. Dissection of human bodies during postmortem examinations became more acceptable, and, with the aid of the newly invented microscope, the structure and potential function of the various receptors, nerves, muscles, and major organs of the body were inspected in detail. Studies of reflex action burgeoned in the eighteenth and nineteenth centuries (see Fearing, 1930). For example, Robert Whytt (1714–1766) performed research with frogs that demonstrated that the spinal cord is essential for mediating the presumably unlearned linkages between external stimuli and specific responses that characterize a reflex. And in the first half of the nineteenth century, the English physiologist Marshall Hall distinguished between voluntary and reflex muscular responses on the basis of his experiments with snakes and newts. He believed that voluntary actions were set in motion spontaneously by central (brain) events and reached the muscles by way of the spinal cord and motor nerves. Reflexes, on the other hand, were described by Hall as unconscious and were elicited by application of appropriate external stimuli, which, after impinging on some sensory receptor, produce their eventual responses via a route covering the sensory nerves, spinal cord, and motor nerves.

In the early nineteenth century Charles Bell in England and François Magendie in France established experimentally that the dorsal roots of the spinal cord have a sensory function and the ventral roots a motor function. Wertheimer (1970) remarks that this was deservedly hailed as an important discovery, even though a similar conclusion had been suggested by Erasistratus in about 300 B.C. and by Galen in the second century A.D.

There are many other aspects of physiological and anatomical work and theorizing in the eighteenth and nineteenth centuries that contributed in various ways to the development of experimental psychology. Among these were: the measurement of the speed of nerve conduction in 1850 by Hermann Helmholtz just a few years after his teacher, the great physiologist Johannes Müller, had said it could probably never be done; the use of human reaction-time measures by Helmholtz in his attempt to substantiate the values for the speed of nerve conduction determined in nonhuman organisms; the demonstration of the electrical nature of nerve impulses and muscular functions; the influence of phrenology (in its simplest form, the doctrine relating conformations of the skull to various mental traits) and subsequent

discussions of the question of whether and where various psychological faculties or functions are localized in the brain; Müller's doctrine of specific nerve energies, which stated that the quality of a sensation is determined by the nerve being stimulated, rather than by the physical properties of the external stimulus itself (see Hochberg, Chapter 3, this volume); studies of the structural anatomy of neurons and the nature of their connections with other neurons. Thompson and Robinson (Chapter 10, this volume) cover many of these and related topics.

As Littman (Chapter 2, this volume) points out, almost all the individuals connected directly with the founding of experimental psychology in Germany were originally trained in medicine and physiology. Their backgrounds must have influenced many of the specific views and techniques that dominated the early years of the new science.

3. Other Biological Sciences. As much as any other source of influence, Charles Darwin's theory of evolution had a profound effect on the development of experimental psychology. Although most of the evidence for his theory was derived from the study of physical traits, Darwin believed that mental as well as physical characteristics would conform to his proposed mechanisms of evolutionary change: Man's intellectual and emotional traits ought to display continuity with those of the species from which Man is descended. In his book *The Expression of the Emotions in Man and Animals* (1872), Darwin discussed a variety of human responses (e.g., certain facial expressions) as vestiges of earlier forms of emotional expression in other species (see Mandler, Chapter 7, this volume). Very rapidly, the idea of a comparative (animal) psychology was transformed from an intriguing prospect into an active area of research—endorsed by Darwin in communications with his younger colleague, George J. Romanes (see Gottlieb, Chapter 4, this volume). This new area of natural science would presumably trace similarities and differences in the lines of descent of mental and behavioral characteristics from one species to another. As we will also see, Darwin's theory provided a central theme (adaptation or adjustment to the environment) of the functionalist movement in America, justified the use of animal subjects in studying fairly complex phenomena like learning and memory, and brought the topic of individual differences to the fore as an important area for study by experimental and quantitative psychologists.

Early work in embryology, genetics, and biological taxonomy also contributed to the development of modern psychology. Boring (1950) notes that the founder of modern taxonomy in botany and zoology, Carolus Linnaeus (1707–1778), not only highlighted for psychology the importance of description, classification, and inductive insight, but also presented the first classification of the "sensible odors" and an early classification of the different tastes.

4. Clinical Medicine and Psychiatry. After many centuries of allusions to demons and witches, unsympathetic treatment of the mentally ill, and various attempts at mere classification of symptoms, a number of neurologists and other medical practitioners of the eighteenth and nineteenth centuries began to view favorably the possibility that mental illness, idiocy, speech disorders, and other forms of psychological dysfunction might eventually be traceable to completely natural causes: some physical defect in the brain or nervous system of the afflicted individual; some traumatic events occurring in the life history of the individual. Battle wounds and tragic accidents involving damage to the head often produced bizarre behavior and dramatic effects on sensory ability, motor movement, memory, and learning and reasoning capacities. Work on hypnosis, though often of questionable merit, did reveal definite therapeutic and anesthetic effects, and led several open-minded individuals to consider its implications for the concept of consciousness and the nature of suggestibility; Boring (1950) believes that early studies of hypnotism represent the beginnings of the experimental psychology of motivation. Within an intellectual milieu that was increasingly materialistic and deterministic (the British psychiatrist Henry Maudsley said in 1867 that mental diseases are diseases of the brain), all these observations pointed toward the eventual acceptance of the possibility of an experimental approach to psychopathology, exemplified by later research in neuropsychology, genetics, psychopharmacology, experimental neurosis, and other areas, described by Thompson and Robinson in Chapter 10 and Maher and Maher in Chapter 13 of this volume. And, in the twentieth century, the views of Sigmund Freud and other psychoanalysts influenced a great deal of research in experimental psychology, as we see throughout this book.

5. Astronomy. Study of the "personal equation" in astronomy was a forerunner of a considerable amount of later work in experimental psychology. This line of investigation is usually traced back to a labor–management disagreement of 1796. D. Kinnebrook, an assistant at the Greenwich Observatory, was dismissed—apparently after several reprimands —by N. Maskelyne, the astronomer royal, because of discrepancies in their judgments of the time when a star crossed a thin wire line in the telescope's eyepiece. Their estimates, important for calibration of the clocks establishing standard times, were based on a complicated method that involved the observer's coordination of visual and auditory cues, his ability to make quick numerical interpolations, and his short-term memory for a previous position of the star. Kinnebrook's readings were considered to be erroneous because they consistently disagreed with his supervisor's.

About 20 years later Friedrich Bessel, a Prussian astronomer, read about the unfortunate Kinnebrook's dismissal. Knowledge of the event evoked interest and sympathy rather than indifference from Bessel, because it

suggested to him that errors of observation as large as those between Maskelyne and Kinnebrook might typically be obtained among even the most experienced astronomers—as a consequence of individual differences in their visual, auditory, memorial, or motor capacities. On subsequent visits to various observatories, his suspicions were confirmed: He compared himself with other astronomers, and them with each other, and frequently found equivalent or even larger differences than had caused the problem at Greenwich. After accumulating a great deal of comparative data on different astronomers, he was able to formulate a set of what he called personal equations, which provided constant time values that had to be added to or subtracted from one astronomer's judgments in order to equate his judgments with those of another astronomer. The source of these errors was considered in a different category from those stressed by previous astronomers; they did not originate from atmospheric or instrument problems, but from "physiological" differences in the observers.

This work by astronomers[3] led to the increasing realization by scientists in various fields that individual differences in judgments had to be carefully taken into account when assessing the reliability of results obtained with human observations; in other words, a principle of relativity applies in such situations, and there is no such thing as an absolute standard of correctness. Bessel's research also set the stage for the work on human reaction time pioneered by Donders and later continued by various investigators of *mental chronometry*; the topic is receiving renewed theoretical and practical treatment today (see Cofer, Chapter 8, and Posner & Shulman, Chapter 9, this volume).

6. Mathematics and Statistics. As Littman (Chapter 2, this volume) recounts, Immanuel Kant, the great German philosopher of the eighteenth century, argued against the possibility that psychology could ever become a science, because he believed that one could not perform reliable experiments on the nature of the mind or measure psychological events in any precise way. Kant's negative conclusion was in part based on his rejection of introspection as a trustworthy technique, and Littman points out the irony surrounding Kant's alternative proposal that nonintrospective, objective observations could yield valuable information. This proposal implied what is essentially a behavioristic approach, but of course the behaviorists, more than a century later, did not find themselves in agreement with very many of Kant's general views.

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[3]Describing an area of research not familiar to many historians of psychology, Pliskoff (1977) has documented how the astronomers J. Herschel, W. R. Dawes, and N. R. Pogson independently formulated Fechner's basic psychophysical law while developing the stellar magnitude scale in approximately 1850. Their work apparently preceded Fechner's statements on the matter by several years.

In the early nineteenth century, Johann Herbart, who developed the concept of the *threshold* and the notion of the *unconscious* and who made important contributions to educational theory and practice, maintained that mathematics could be profitably applied to psychology. Even though he thought that the study of the mind could not be approached experimentally or physiologically, he did propose mathematical assumptions and equations in support of the general laws he formulated concerning, for example, the inhibition or facilitation of one idea by another, the fusion of several ideas, and so forth. Boring (1950, pp. 258–260) provides a nice illustration of Herbart's mathematical methods. However, criticizing Herbart's premises, he comments that Herbart "exhibited the not uncommon case in science in which inadequate data are treated with elaborate mathematics, the precision of which creates the illusion that the original data are as exact as the method of treatment. It is often that the person who works well with mathematics lacks the gift of criticism against experimental results or even against his assumed postulates."

Also in the early nineteenth century various astronomers and mathematicians began to study variable errors of the kind pointed out by Bessel as a secondary observation. He had concentrated on the constant errors in one direction or the other that arose in comparing different astronomers, but he had also commented on the variability of these positive or negative deviations. Only "on the average" did Astronomer X observe star transits 0.37 seconds later than Astronomer Y. Pioneering mathematicians like A. de Moivre, P. S. Laplace, and C. F. Gauss, founders of modern probability theory in the eighteenth and nineteenth centuries, derived the equation for the normal curve and offered several indices for expressing the magnitude of variable errors. Later implemented in the original studies of human memory performed by Hermann Ebbinghaus, in the work of the early psychophysicists, and in Francis Galton's studies of the inheritance of various traits in humans, such statistical procedures and their numerous offshoots also influenced the subsequent development of many areas of experimental psychology.

Throughout the history of experimental psychology, simple equations have been fitted to obtained data, but the use of formal mathematical models in psychology is a relatively recent trend (see Estes, Chapter 14). It extends the centuries-old tradition of using such approaches in physics, chemistry, biology, and other sciences.

B. Wundt and the Founders of Experimental Psychology

Although this commemorative volume was planned to appear in 1979—exactly 100 years after the date generally accepted as the year in which Wilhelm Wundt's laboratory opened in Leipzig—the setting of a time and

place for the official founding of experimental psychology naturally involves a somewhat subjective decision. Writers on the history of the field have frequently questioned whether Wundt should receive as much credit as he has. And, even granting Wundt's right to the honor, others have argued about whether the year 1879 is the most appropriate date for celebrating his declaration of psychology's independence from the other sciences and philosophy; some of the books and articles he published well before 1879 contained clear statements of his beliefs and intentions in that direction. Finally, there have been wrangles over the actual date that Wundt's laboratory first became a functioning unit and over whether William James' use of a couple of rooms for experimental demonstrations at Harvard in 1875 should be taken to mean that the American really deserves priority. James had rebutted G. Stanley Hall's claim of the first laboratory of psychology in America (at Johns Hopkins in 1883) by supplying information about his own 1875 facilities. Discussing these controversial points, Boring (1965) reminds us that Carl Stumpf's "laboratory" in Germany may predate these others. It consisted of a set of tuning forks Stumpf carried around in a cigar box before 1875.

No one would dispute the assertion that valuable methods had been devised and actual experimental work on psychological processes had begun before 1879. Among other contributions, the astronomer Bessel's work on the personal equation in the early nineteenth century would be considered a good example, as would investigations of various physiologists on sensation and movement, specific nerve energies, brain localization of function, the speed of neural transmission, and reflex action. Closer to what many people might be willing to label truly "psychological" inquiries were E. H. Weber's studies of tactile sensitivity (early 1830s), G. Fechner's development and use of the psychophysical methods (between 1850 and 1860), H. Helmholtz's and E. Hering's research on vision and audition (beginning in the 1850s and 1860s), F. Donders' investigations of human reaction time (approximately 1865), and even some of the pursuits embarked upon by the versatile F. Galton in the 1860s. However, these scientists were not specifically interested in the advancement of psychology as a science.

Obviously, Wundt has received the lion's share of the credit because he explicitly called himself a psychologist, because he formally established a new and independent domain of science, because he tried to integrate many diverse streams into an organized discipline, and because so many of the early leaders in experimental psychology came to study with him. Wundt himself used the term "experimental psychology" for the first time in his *Contributions to the Theory of Sense Perception*, published between 1858 and 1862 while he was Helmholtz's assistant at the new physiological institute at Heidelberg, where Wundt remained in various capacities until 1874. In that treatise Wundt frequently gave signs that he viewed his work as part of a

discipline separate from physiology. His *Fundamentals of Physiological Psychology* (completed in 1874) has been called by Boring the most important book in the history of modern psychology; it represented Wundt's attempt to apply to the study of the mind a variety of methods that he considered analogous to those he had himself employed as a physiologist. For Wundt, the words *physiological psychology* and *experimental psychology* were virtually synonymous because he believed that psychology was a science only to the degree that it employed methods and approaches like those a physiologist would use. In his opinion, the main difference between the two fields concerned their point of view: Physiology, like physics, observes its subjects from the outside, psychology from the inside. However, in both cases, similarities among the reports of different observers are the primary source of evidence for the reality of the basic processes. Because of the important influence of Wundt's *Fundamentals* on the new psychology, its publication date has frequently been justified as marking the start of experimental psychology. In that case we could have celebrated the centennial of Wundt's founding of the discipline 5 years before 1979.

After briefly holding a chair of "inductive philosophy" at the University of Zurich in 1874–1875, Wundt became Professor of Philosophy in 1875 at Leipzig, where he stayed for the rest of his long career (45 more years). Bringmann, Balance, and Evans (1975), in a concise biography of Wundt that also contains many valuable references, describe the modest beginnings of his psychological institute:

> On his arrival at Leipzig, Wundt had been assigned merely a small outlying room in the "Konvikt" (refectory) building to store the equipment that he had brought with him from Zurich. It was in the same room, which had previously served as a lecture hall, that he managed after four years to open his laboratory in 1879 as a "private institute," which he supported out of his own pocket until about 1881. Two more years were to pass before the laboratory was officially recognized by being listed in the university catalogue. This recognition came only after Wundt had been offered a chair at Breslau University [p. 293].

Thus Wundt's arrival at Leipzig and the happenings in his assigned room did not exactly take the scientific world by storm; and the transformation of his room into a functioning laboratory was apparently not accompanied by any particular fanfare or ceremony. The first substantial research that was performed in the laboratory involved a dissertation on reaction time carried out by Max Friedrich beginning in the autumn of 1879 and eventually published in Volume 1 of *Philosophische Studien*, edited by Wundt. Among the investigators present during the inaugural years of the institute were several men who later became leaders in the field: James McKeen Cattell, G. Stanley Hall, and Emil Kraepelin. Within a few years students were arriving

from around the world to study with Wundt. Enrollment in his courses doubled about every 15 years, reaching a peak of 620 students in the summer of 1912. Wundt ended up sponsoring 186 Ph. D. dissertations, about a third of which apparently involved purely philosophical topics (Tinker, 1932). Despite Wundt's emphasis on introspection as the distinctively "psychological" technique—to be used for analyzing conscious experience into its elements—it is perhaps significant that much of the research at Leipzig involved relatively simple reaction-time measures and standard psychophysical determinations in which, for example, the subject supplied trial-by-trial reports about the mere presence or absence of a particular stimulus. While research was going on at the original institute and the better equipped facilities and building that succeeded it in later years, Wundt devoted a great deal of time to writing authoritative books on a wide range of topics. These included many areas of inquiry that he thought could *not* be investigated experimentally but that still greatly interested him—for example, social customs, child development, the growth of cultures, animal psychology, and higher mental processes like thinking, language, and problem solving. Philosopher, psychologist, physiologist, natural historian, anthropologist—Wundt had many faces (see Blumenthal, 1976, for a reappraisal of several of Wundt's views, with evidence that he has often been grossly misunderstood on some important issues by both his followers and his opponents).

Regardless of exactly when we date the founding of experimental psychology, the field was burgeoning by the end of the nineteenth century. However, its geographical center soon began to shift across the Atlantic, and from then on the study of experimental psychology was concentrated in North America.

C. The Twentieth Century

The first few decades of the twentieth century were marked by the development of three or four different general approaches to the study of experimental psychology. This was the so-called period of "schools" or systems in psychology (see especially Heidbreder, 1933, and Woodworth & Sheehan, 1964, for clear and detailed discussions of these various points of view). Most textbooks covering the history of scientific psychology devote considerable space to the similarities and differences between these systems, their often forceful and eloquent leaders, their methodologies, their views on the nature of psychology, their approach to theory construction, and the weaknesses that eventually led either to the complete downfall of a school (as in the case of structuralism) or to such extensive modifications that the school lost much of its organized structure, being absorbed into more eclectic approaches or being divided up into its own separate camps. Research performed within the original systems—structuralism, functionalism, behav-

iorism, and Gestalt psychology—has had a significant impact on contemporary psychology, and many of the theoretical and methodological issues that characterized the controversies among the schools still have their counterparts today. However, few psychologists are now willing to be labeled on the basis of any overall, definite systematic approach; instead, they are identified primarily by the specific research areas or problems on which they work.

Did the battles between the original schools of psychology in the long run facilitate or hinder the growth of psychological science? Attachment to a particular school, it is true, helped to guide one's research in various areas, offered a way of conceptualizing and organizing current knowledge, provided specific tools and preferred methods for performing experiments, narrowed the scope of one's inquiry to manageable proportions, and furnished morale-building incentives for engaging in certain kinds of research. The ensuing controversies stimulated interest in various phenomena, not only from students and practitioners of experimental psychology but also from the general public. However, perhaps the time spent propagandizing and attempting to "score points for our side" could have been better devoted to more constructive efforts. Schools encouraged intolerance, fanaticism, and orthodoxy. In fact, this is the way that many of the so-called functionalists of the early twentieth century felt. Characterized as a school by an outsider—E. B. Titchener, the structural psychologist who carried to an extreme the views he acquired in Wundt's laboratory—functionalism resisted the attachment of a definite label to its endeavors and general beliefs. When first approached to write a chapter on functionalism for Carl Murchison's series of books describing current "psychologies," Harvey Carr, generally considered a leading functionalist by his contemporaries, told Murchison, "I don't like your damn book!" Carr believed that Murchison's series magnified the differences among experimental psychologists and did not successfully portray the advances that the science of psychology was making or encourage cooperation among psychologists of various persuasions toward achieving satisfactory solutions to difficult problems.

Regardless of the permanent value of these early 20th-century developments, it is hard to follow the history of experimental psychology without some prior exposure to the major goals, methods, and themes that marked and divided these schools. Therefore, a brief sketch of each is presented here; however, there will be little or no attempt at critical evaluation. Numerous criticisms, specific and general, will be found in the subject-matter chapters that constitute the bulk of this volume.

1. Structuralism. As expressed in the writings of Edward B. Titchener, Wundt's staunchest follower, structuralism represented an attempt to examine the basic structure of the human mind rather than its operations or

functions or purposes, which Titchener said were aspects of the mind prematurely being investigated by those he labeled functionalists. He declared that isolation of the basic mental elements should precede any study of their combination and function, just as in biology the identification of specific structural features of organisms (i.e., anatomy or morphology) usually precedes the study of the functions of these structures (i.e., physiology). The structuralist was interested in "the analytical study of the generalized normal adult mind" through the method of controlled introspection—the one distinctively psychological method. According to Titchener, anything that did not appear in conscious experience was not really a part of psychology. Thus, the structuralist's definition of psychology was very narrow; it could not include topics like individual differences, motivation, child development, psychosis and neurosis, animal behavior, or practical applications. The structuralist considered "behavior" to be part of the field of biology, rather than psychology, because it did not involve experience as dependent on the experiencing organism. Psychology was to be a "pure" science, independent of physiology and biology, and based on the introspections of very well-trained adult subjects seeking to isolate the elements of consciousness, along lines analogous to a chemist's analysis of material into basic, irreducible elements.

The "mistake" most often made by naive introspectors involved what Titchener called the *stimulus error*, an understanding of which helps one gain a good perspective on Titchener's approach. This kind of mistake occurred when the observer did not report his actual experience (consciousness of certain elements like hues, textures, or brightnesses), but talked in terms of what he had inferred, interpreted, or learned about a stimulus object (e.g., making the statement: "I see a penny."). Titchener admitted that it may be more natural to describe objects than to analyze them into basic elements, but he insisted that introspective psychology cannot accept the former type of report. Only if one successfully eliminates inference and meaning from the introspective report can the basic elements of experience be clearly isolated. Thus, a Titchenerian observer could not announce that a person remained the same size as he moved further and further away, because that statement presumably involves an inference and not a direct experience. Hochberg (Chapter 3, this volume) has much to say about these and related matters.

Of course this artificial type of analysis was difficult to master (and, as we will see, the Gestalt psychologists criticized the structuralist's approach because they thought breakdown into such elements was not only unnatural but also useless and even ridiculous). However, after much training and practice, Titchener's observers were apparently able to provide reliable data on certain topics. Although his conclusions were somewhat modified later in his career, Titchener declared, on the basis of introspective data from a good number of practiced subjects, that sensations, images, and feelings were the

basic elements of the mind and could be compounded into perceptions, ideas or thoughts, and emotions, respectively. He further characterized these elements in terms of their different attributes (the most important were quality, intensity, clearness, and duration). Eventually Titchener boasted that more than 44,000 separate elements had been counted for the mind; Boring (1942) remarks that "as against the 64 then known elements of chemistry, the mind seemed pretty well provided for [p. 10]." Titchener (1899) concluded: "Give me my elements, and let me bring them together under the psychophysical conditions of mentality at large, and I will guarantee to show you the adult mind, as a *structure*, with no omissions and no superfluity [p. 294]."

Thus the structuralist's approach, which claimed to be truly scientific and experimental, centered on the analysis of sensation and perception, was extremely narrow in its views concerning the scope of psychology, and was almost completely dependent on the reliability of the reports of exceptionally well-trained introspectionists. Eventually, the lack of reliability from observer to observer and laboratory to laboratory proved to be one of the major reasons why structuralism died; for example, we discover in this volume that irreconcilable differences arose on the question of whether images are always present during thinking and problem solving. Structuralism never recovered from the various methodological criticisms that behaviorists, Gestaltists, and other psychologists directed at it. Today, there are no structuralists in the Titchenerian sense—the school is often said to have died with Titchener in 1927—but much basic work, especially on sensory-perceptual processes and reaction time, did emerge from their laboratories and institutes, most frequently as a result of investigations that did not involve the extensive use of lengthy introspective reports. And, of course, in a very general sense, analysis into sensory components or units (but not by means of introspection) is still a major theme of current research on sensation and perception (see Hochberg, Chapter 3, this volume).

2. Functionalism. Broad in scope and difficult to characterize in any very concise way, functionalism nevertheless represented a definite step away from a focus on reports of conscious experience and toward the use of objective measures in experimental psychology. There was great variation in the systematic approaches and topical interests of those psychologists who are usually classified as functionalists; but they are often described as tolerant, biologically oriented, eclectic, relativistic, democratic, quantitatively inclined, and practical-minded. Although they accepted introspection as a useful method, they generally preferred to apply it in relatively simple tasks utilizing naive rather than very practiced or sophisticated subjects. Unlike for the structuralists, no definite leader ever emerged as the spokesman for the functionalist movement, which represented the first approach to psychology

that originated in America. It has often been claimed that functionalism ideally suited the American Zeitgeist—practical, down-to-earth, individualistic, democratic—whereas structuralism was more congenial to the intellectual climate in Germany, which was more abstract, authoritarian, and philosophical.

For many reasons, including his opposition to the artificiality of the structuralists' analytical approach, his stress on the functions and purposes of consciousness, and his treatment of psychology as a biological science, William James (1842–1910) is considered a direct precursor of functionalist views. For example, he thought that attempts to decide whether feelings can be reduced to sensations, or are separate elements, tell us nothing significant about man. However, John Dewey (1859–1952), later an important figure in educational psychology and a leading philosopher of social change, wrote an influential paper in 1896 that is frequently credited with launching the new movement. Although the paper was mainly a critique of the reflex-arc concept, its condemnation of the overly analytical, atomistic use of that concept in psychology revealed a similar dissatisfaction with the elementaristic framework of the structuralists. Dewey emphasized the inherent continuity and coordinated nature of mental activity and implied that psychology should avoid unwarranted analysis into artificial elements—either the simple stimuli and responses said to constitute the reflex arc or the sensory elements stressed by the Titchenerians. James Angell (1869–1949) and Harvey Carr (1873–1954) at the University of Chicago, G. Stanley Hall (1844–1924) at Johns Hopkins and Clark Universities, as well as James McKeen Cattell (1860–1944), Edward L. Thorndike (1874–1949), and Robert S. Woodworth (1869–1962) at Columbia University, were the individuals whose names are most often associated with the functionalism of the first quarter of the twentieth century. Woodworth himself remarked that functional psychology is not a school of psychology but a middle-of-the-road position.

The general concepts of Darwinian evolution provided an important background for the functional psychologists. They asked, for example, how the processes of learning, motivation, sensation, and perception could play a role in the adaptation and survival of organisms, and they were greatly interested in the study of individual differences and child development. The functionalists were also strongly influenced by the associationistic tradition, handed down via the British empiricist-philosophers. Consequently, they performed many experiments examining the applicability of connectionistic principles to such problems as the factors affecting the ease of learning new responses, the rate of formation and the degree of retention of associations within a series of verbal items, and the transfer of learned responses from their initial training context to new situations (see Cofer, Chapter 8, this volume). Unlike the structuralists, who insisted that isolation of the elements of the

mind had first to be achieved before the purposes of these structures could profitably be studied, the functionalists expressed strong interest in the usefulness of the mind or consciousness in adapting an organism to its environment. Carr said that "psychology is concerned with all those processes that are directly involved in the adjustment of the organism to its environment." Therefore, the functionalists were committed to the study of topics that had applied or practical value—motivation, intelligence testing, motor skills, work and fatigue, and educational or clinical problems.

The functionalists amassed a great deal of experimental data in diverse areas of psychology and helped to build bridges between psychology and biology. Many of their emphases and themes survive as features of the mainstream of today's experimental psychology. But even though the movement signified a trend in the direction of greater methodological objectivity, the willingness of its participants to accept both mental events and behavior as topics for psychological study gained the opposition of several psychologists who felt that psychology had still not sufficiently rid itself of mentalistic, subjective approaches and terms. One of these critics was a doctoral student of Angell's at the University of Chicago, John B. Watson, who became the leader of a vigorous and radical new movement.

3. Behaviorism. In the second decade of the twentieth century the difficulties inherent in the use of introspective data were becoming more and more apparent. It seemed time to propose and develop an approach to psychology that renounced such intangible concepts as mental activity, consciousness, and experience, and instead concentrated exclusively on the observable, directly measurable actions of organisms interacting with their environments. As Max Meyer (1873–1967) aptly phrased it in the title of his behavioristically oriented 1921 textbook, such a system would focus on the *Psychology of the Other One*, rather than on the private, scientifically unverifiable reports of one's own mental life. Human observers or appropriate apparatus could objectively record the gross movements and verbal responses of another person—analogously to the methodology of the other sciences—but only the person himself could ever be the source, and a rather unreliable one at that, of information about his own feelings, headaches, and itches. The objective method would presumably produce the consensus among observers that is required in a science.

The themes of the behavioristic movement are best expressed in excerpts from Watson's keynote article (1913). Typical of Watson, it was exaggerated in its criticisms and propagandistic in its tone, but it served as the manifesto that attracted many psychologists to his camp:

> Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior.

> Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon ... interpretation in terms of consciousness.... The time seems to have come when psychology must discard all reference to consciousness.... My psychological quarrel is not with the ... structural psychologist alone. The last fifteen years have seen the growth of what is called functional psychology.... I have done my best to understand the difference between functional psychology and structural psychology. Instead of clarity, confusion grows upon me.... We can write a psychology, define it as ... [the "science of behavior"], and never go back upon our definition: never use the terms consciousness, mental states, mind, content, introspectively verifiable, imagery, and the like.... It can be done in terms of stimulus and response, in terms of habit formation, habit integration, and the like.... My final reason for this is to learn general and particular methods by which I may control behavior.... If this is done, work ... on the human being will be comparable directly with the work upon animals [pp. 158–170].

Thus psychology was not to be the science of conscious experience (structuralism) or of mental activity and behavior (functionalism), but only of behavior. According to Watson, the various vague mechanisms or forces that had been posited by many philosophers and psychologists to operate within us—including such unobservable, centrally elicited processes as visual imagery or will—should be dismissed from consideration in psychological science; psychology must focus on peripheral, objectively defined actions—that is, movements of skeletal and smooth muscles or secretions of glands. Given a discrete external stimulus or a complex stimulus situation, the task of the experimenter is to predict the subsequent response; given a response of the subject, the task of the experimenter is to name the stimulus or stimulus situation that produced it. Of course, Watson admitted that behavior not visible to the experimenter's eye—implicit, covert behavior—is going on continuously inside the organism. His famous and influential theory of Thinking took account of this and postulated that thought mainly involved tiny movements of the muscles ordinarily used in speech. Although perhaps currently unobservable, such movements were potentially measurable; as technology advanced, new instruments would allow precise recording of these delicate responses. Therefore, according to Watson, thought was not a mysterious process initiated and controlled in the brain, but consisted of specific behaviors in response to specific stimuli and followed basic laws no different in kind from those governing more molar, external forms of behavior (see Jenkins, Chapter 5, this volume).

Watson listed several ways of studying behavior objectively. One involved the mere observation of behavior in an experimentally controlled or natural setting. Another general method comprised various testing procedures such as those already in use to measure intelligence or motor skills. A third method involved the recording of verbal responses made by a subject—for example

"Yes" or "No" judgments in a psychophysical experiment, or certain words evoked by particular stimuli. On this point Watson was frequently accused of making an alarming concession and of retaining introspection under the name of verbal report, but he maintained that he was merely treating a verbal response as just another form of behavior, not as a source of information about conscious experience or internal events in the manner of many earlier psychologists. Watson's final method, his favorite, employed the conditioned reflex technique developed by I. Pavlov and V. Bekhterev. Variants of the last method were used in Watson's well-known experiments on the conditioning and removal of fear responses in young children, studies that are referred to in several chapters of this book.

In American experimental psychology, Watson's views, combined with those of the functionalists, moved the focus of research away from the study of sensory processes—psychology's central interest since Wundtian times—in the direction of work on learning, especially in animals (which was widely believed to necessitate an objective approach) but also in humans. Complex habits were conceptualized as aggregates or combinations of simpler ones, and there was confidence that even the most complicated habits of humans would eventually be explicable on the basis of our scientific understanding of the fundamental principles governing the acquisition, performance, elimination, and compounding of simple responses. Although stressing observable stimuli and responses, and not ideas or sensations or images, this approach is clearly atomistic and connectionistic, resembling in broad outline the old pre-experimental theories of association that I mentioned earlier in this chapter.

Watson's approach had a large impact inside and outside of psychology and was easy for the general public to understand. His extreme beliefs concerning the dominance of environmental over genetic factors suited the American democratic spirit; it was hard for the man in the street to view unfavorably the enthusiastic and distinguished psychologist who himself started out as a South Carolina farm boy and who now claimed that science would permit us to educate our children to achieve almost any professional ambition. Watson also presented definite views on how criminals should be treated and how mental illness should be handled; he persistently declared that behaviorism would inevitably benefit society in many other ways as well. Commenting on Watson's 1924 book, the *New York Times* said that it "marks an epoch in the intellectual history of man," and the *New York Herald-Tribune* declared that "perhaps this is the most important book ever written." Watson's later books and articles on child development and behavior, though sadly lacking a solid scientific basis, offered parents some easy rules to follow and affected the way in which many children were brought up in the 1920s and 1930s (see Cairns & Ornstein, Chapter 11, this volume).

It was not long before most psychologists began to have serious doubts about whether the kinds of simplistic approaches that Watson had proposed

would really be able to encompass all the phenomena and processes that psychology should set itself to study and explain. Dissatisfaction with Watson's views eventually took two main directions: to improve the behavioristic framework or to reject it. Along the positive pathway moved several more-sophisticated forms of behaviorism ("Neobehaviorism"), which sought to decrease the movement's propagandizing of the public and to increase the interplay between actual experimentation and theory development that was almost absent in Watson's work. These "behavior theories," focusing on data from studies of learning and motivation in animals, engaged the attention of numerous experimental psychologists, especially in the period between 1930 and 1960, only to lose much of their influence in the last two decades, except for Skinner's version. The rise and decline of these general behavior theories is a remarkable and revealing story, narrated in detail by Jenkins (Chapter 5, this volume) and a recurring theme or undercurrent in many other chapters of this book.

The other reaction to the weaknesses of simple behaviorism, and later to neobehavioristic approaches, involved the rejection of some of the movement's major themes and emphases—not its objective methodology, but its stress on animal work, its relatively narrow associationistic bias, and its reluctance or inability to deal satisfactorily with what critics, especially those interested in human psychology, considered very significant problems to study. For example, behaviorists did not pursue the relations among perception, learning, and memory; the topics of thinking, attention, concept formation, problem solving, and visual imagery; the question of levels of organization in the nervous system and in behavior; and, more abstractly, the processes or stages that intervene between external stimulus and observable response. This dissatisfaction with behavioristic approaches did not result in any definite alternative framework for many years, but is reflected in what is today called cognitive psychology.

The fourth original school of psychology, Gestalt psychology, possessed several features that anticipated this contemporary movement, and we turn back again in history to describe some of their beliefs and approaches.

4. Gestalt Psychology. At approximately the same time (1910–1915) as Watson and the early behaviorists in America were boldly and successfully winning adherents to their radical views, another group of psychologists in Germany was mobilizing to attack standard introspectionism from another direction. This movement, led by Max Wertheimer, Kurt Koffka, and Wolfgang Köhler, was characterized by the belief that prior approaches to psychology, and to the subject of perception in particular, were too atomistic and analytical to be of any great value in understanding the basic processes involved in behavior and experience. The word "Gestalt," which has no perfect English equivalent but may be loosely translated as "configuration" or "pattern" or "form," underscores the major theme of the new movement and

brings to mind John Stuart Mill's notion of mental chemistry (see p. 14)—the idea that objects or wholes are not reasonably viewed as simple aggregates of their elements but instead represent something more than or different from the sum of their individual parts. Michael Wertheimer (1970) lists relational determinism as one of the Gestaltists' fundamental principles—that is, "properties of parts depend upon the relation of the parts to the whole; part qualities depend upon the place, role, and function of the part in the whole."

These notions can be illustrated in many ways. For example, a melody is not merely a combination of different notes; it is easily recognized when played on another instrument, hummed by a very young child, transposed to a different key, or perhaps even tapped out on a table top—because the same basic pattern or structure is retained, despite large changes in the individual elements. Woodworth and Sheehan (1964) provide a different illustration:

> Put down three dots, about a half-inch apart but not in a straight line. What do you see? A triangle—not just three dots. Now add one more dot close to the three. The triangle gives way to a quadrilateral. With effort you may get back the triangle and see the added dot as a separate thing, but the quadrilateral seems more real, unless you have put one of the dots at a considerable distance from the others. It seems that some internal relationship within the figure has more to do with what you see than any effort you may make to group or associate the "elements" that "compose" it [pp. 5–6].

Thus the Gestaltists were greatly dissatisfied with the analytical and associationistic approach to experience taken by the Wundtians and Titchenerians. Extensive practice was necessary to produce subjects who avoided the stimulus error and described the elements or contents of their conscious experience in the way structural psychology demanded; the fact that such strenuous efforts were required was a clear demonstration to the Gestaltists of the artificiality and fallaciousness of the whole approach, and they doubted whether any findings from such research could have significant or lasting value. The Gestalt psychologists preferred *phenomenological* descriptions of experience, in which naive, unpracticed subjects report, naturally and directly, the way that various things appear to them.

As time passed, the Gestaltists and behaviorists discovered that their mutual dissatisfaction with structural psychology was one of the few things they shared. The Gestaltists felt that behavioristic interpretations of almost every phenomenon, including those of learning and problem solving, were faulty because the behaviorists, too, were guilty of atomism and associationism; behavioristic analyses of complex behavior in terms of aggregates of stimulus–response linkages, or reflex units, incorporated essentially the same kind of blunder as the structuralist's attempts to break down conscious experience into basic elements. The Gestalt psychologists viewed everyday learning and problem solving as flexible and intelligent, characterized not by the gradual accretion of stimulus–response connections but by reorganiza-

tions of the perceptual field (e.g., the sudden "grasping" of a relationship or the realization of the correct principle to apply). Such "insightful" solutions were said to conform to laws of organization analogous to those the Gestaltists emphasized in accounting for various phenomena of perception. Köhler's famous experiments with chimpanzees and other nonhuman subjects presumably demonstrated that they, too, could exhibit insightful behavior, which contrasted with the rather "blind" trial-and-error learning stressed by most animal psychologists (see Jenkins, Chapter 5, this volume). Wertheimer's investigations of productive thinking in young children also provided many dramatic examples of what Gestaltists called insightful rather than blind solutions.

The Gestalt psychologists generally disapproved of explanations that stressed the role of past experience in learning, perception, and other psychological phenomena. They tended to favor nativistic explanations of behavior and experience, in contrast to the generally empiricistic views of the structuralists, functionalists, and behaviorists (see Hochberg, Chapter 3, this volume). According to the Gestaltists, the appearance of the world depends more on the innate organization of our brains—or on the present context in which we find ourselves—than on the details of our past exposure to various objects and situations.

Despite the vagueness of many of the Gestaltists' concepts, the weaknesses in the physiological (brain-field) theories that some of them thought would account for phenomenal experience, and the "demonstrational" nonquantitative nature of much of their research, their criticisms of other approaches struck home and provided alternative views to those expressed by the early behaviorists and, later, by most of the neobehaviorists. The development of social psychology was greatly affected by the research and field-theory interpretations of Kurt Lewin, who is considered a Gestalt psychologist by most writers (see Steiner, Chapter 12, this volume).

Present-day cognitive theory in psychology—with its emphasis on organization, structure, relationships, the active role of the subject, and the important part played by perception in learning and memory—reflects the influence of its Gestalt antecedents as much as it does the general objective methodology bequeathed to it by the behaviorists (see Cofer, Chapter 8, and Posner & Shulman, Chapter 9, this volume).

V. EPILOGUE AND PROLOGUE

We have seen that the founding and early development of experimental psychology represented a confluence of many different streams of thought and research—especially from philosophy, physiology and anatomy, and evolutionary theory, but also from other areas of biology, clinical medicine

and psychiatry, astronomy, mathematics, and statistics. The great accomplishments of science during the two or three centuries preceding the founding of experimental psychology were an additional source of inspiration and encouragement to the persons who brought the study of the mind into the laboratory and who hoped that psychological experimentation would someday provide us with laws as universal and applicable as those of physics or chemistry. Then, as now,there was the strong belief that a solution to the problem of how the mind or brain actually works would eclipse all prior scientific achievements.

Looked at in broad panorama, experimental psychology concentrated first on the topics of sensation and perception, with its primary methodology involving introspection as a source of information about the elements or contents of conscious experience. As time passed, there was a strong reaction against the narrow methods and limited scope of the psychology practiced by Titchenerian structuralists; and eventually experimentalists began to move in a more objective direction, including many additional topics within the purview of the field and examining psychological phenomena and processes in terms of their adaptive significance and practical value. Learning, memory, and motivation became topics of central importance, replacing the old focus on sensory and perceptual processes. The behaviorists carried the banner of objectivity to an extreme and argued that words like imagery, perception, and consciousness—as well as centralistic or mentalistic explanations—could be dispensed with. These persons and their more sophisticated, modern descendants placed work on animal learning and motivation at the center of their behavioral research. The Gestalt psychologists offered a different, stimulating, but unfortunately rather vague view of psychology's problems. They abhorred the associationistic-atomistic outlook and methodology of both the structuralists and the behaviorists, and proposed instead a more holistic approach based on various principles of organization and on a particular theory of how brain patterns underlie our phenomenological reports. Their concentration was in the field of perception, but they made constant efforts to indicate relations between perceptual processes and the mechanisms of learning, memory, problem solving, and motivation.

Today's experimental psychology has inherited some of the characteristics of its quarrelsome forebears. Controversy is perhaps more muted these days, and objective methods are preferred by almost every investigator. However, there are still definite differences of opinion between those workers who follow a rather strict behavioristic program and dislike speculating very much about the (inferred) processes that intervene between external stimuli and observable responses and those workers, often labeled cognitive psychologists, who rather freely postulate and attempt to qualitatively and quantitatively assess various stages, structures, or operations that occur inside the organism and are eventually reflected in measures of overt behavior.

Global theories or "systems" that seek to encompass many, if not all, areas of experimental psychology, are rare today; experimentalists and theoreticians generally set themselves relatively modest goals—to explain a particular phenomenon, to formulate a theory integrating data in a limited field. There are both broadening and narrowing trends in present-day psychology. Certain areas of psychology are apparently merging with other disciplines: Some workers view cognitive psychology as a combination of psychology, computer science, linguistics, and mathematics (and call it *cognitive science,* as Posner & Shulman, Chapter 9, this volume, suggest); physiological psychology is much more molecular and reductionistic (neurophysiological, anatomical, neurochemical, etc.) than ever before, causing Thompson and Robinson (Chapter 10, this volume) to remark that many contemporary workers in this field really should be and often are now labeled neuroscientists; and even that old focus of the behavioristic enterprise, animal learning and conditioning, is broadening so as to take into account very relevant work in ethology, evolution, ecology, embryology, and development.

Although allegiances with fields outside psychology are growing and flourishing—a happy circumstance—there has been in my opinion an unfortunate decline in the scope of experience and interest that most experimental psychologists possess in areas of psychology outside their own specialties. The sensory or physiological psychologist does not normally want to know much, if anything, about research in child cognitive development or social psychology; the typical cognitive psychologist cares little about studies of animal learning and motivation, or models of human psychosis; the expert in animal learning does not usually even glance at the journals *Perception and Psychophysics* or *Memory and Cognition.* Perhaps we will eventually be forced to surrender the old belief that psychology is a coherent science—that all the areas represented in this volume are interrelated and form a core of knowledge, techniques, and theories that are useful to any psychologist, regardless of his or her principal interests. However, retention of this belief in the unity of psychology may very well be desirable, and, if so, it ought to be fostered by an appreciation of the history of experimental psychology, as narrated in this and other books. Crossing the boundaries of many of experimental psychology's traditional fields are numerous themes and issues that have confronted psychologists for most of the past century: among others, the nativism-empiricism dispute, the levels-of-analysis (molecular-molar) question, the peripheralistic (behavior-centered) vs. centralistic (knowledge-centered) focus, the value of physiological reductionism in "explaining" psychological laws, the meaning and utility of verbal reports (phenomenological or more behavioristic), the view of the organism as a relatively passive recipient of stimulation and a performer of responses vs. the active, participatory role assigned the subject by other views, an emphasis on

description vs. a stress on explanation. An understanding of how these and other themes are reflected or treated in research and theory in many different areas of experimental psychology may help us considerably when we have to conceptualize and attack problems in our own special area of interest.

Regardless of its inconclusive disputes, intermittent fads and fashions, and occasional identity crises, scientific psychology has apparently compensated society for its (sometimes grudging) support. In the last chapter of this volume Estes records a number of positive contributions made by experimental psychologists—ranging from the determination of the limits of various human capacities to certain laws or functions that have a substantial amount of generality. He specifically discusses two areas involving valuable practical applications of laboratory work: *engineering psychology,* which concerns, among other things, the design of machines, displays, tools, and communications equipment for industrial, military, commercial, and entertainment uses; and the *applied experimental analysis of behavior,* based primarily on operant-conditioning principles, which has yielded successful techniques for modifying undesirable behavior in schools, prisons, clinics, and in individuals with particular habits (e.g., smoking or overeating). Programmed textbooks, token economies, computer-assisted instruction, and behavior therapy are methods widely known and applied today in one form or another.

Besides the applications mentioned by Estes, other chapters document additional practical contributions of experimental psychology. Work in the field of *psychopharmacology* (see Thompson & Robinson, Chapter 10, and Maher & Maher, Chapter 13, this volume) has led to the discovery and extensive use of psychoactive drugs in the treatment of patients with various behavioral problems. *Biofeedback* as a technique comes in many shapes and forms, but it originated in behavioral research centered on conditioning procedures that might enable organisms themselves to control supposedly involuntary responses—blood pressure, cardiac patterns, skin temperature, stomach contractions, and so on. Although its positive features have often been abused or exaggerated, biofeedback has demonstrated potential value for treating several physical and "psychosomatic" disorders (see *Biofeedback and Self-Control,* 1970–1977). Work in human learning and memory (see Cofer, Chapter 8) has implicated a number of factors (e.g., the distribution of practice, the organization or grouping of the material to be learned or memorized, the ease of producing visual images) that can be and are being exploited in a variety of practical educational settings. And a recent book by an experimental psychologist studying memory and cognition has offered valuable and effective suggestions on *How to Solve Problems* (Wickelgren, 1974). For these and many other reasons, experimental psychologists need not be defensive about the relevance of their work to the needs of society.

If William James were to be granted a few months back on this planet—perhaps to serve only as a highly competent reviewer for some government

agency assessing the progress of experimental psychology in the twentieth century—I suspect that on his final pink evaluation form he would check neither the box marked "1" nor the box marked "5," where "1" refers to "stupendous" and "5" refers to "abysmal." Psychology is now considerably more than "the hope of a science," although it is not a very well-integrated science. The ideal of a unified science may be unattainable or inconceivable, as some critics have maintained, and could account for why the "Galileo or Lavoisier of psychology" that James predicted would surely come has not yet put in an appearance. We still do not have any real understanding of what happens in the brain when some complex object is perceived, or a poem is memorized, or the correct solution to a problem leaps to mind, or one person is attracted to another; and therefore James would be at least mildly dissatisfied with our progress toward uncovering the relations between physiological and psychological factors. We still do not know exactly how man differs in his psychological makeup from nonhuman organisms, and whether any presumed differences are qualitative or quantitative; with the development of new techniques for "teaching language" to chimpanzees, one of the standard distinctions between man and beast is even being questioned.

As was the case for James and the early psychologists of the nineteenth century, we still grope in a great darkness. But fortunately there are now a number of blinking lights to guide us along the way. The authors who contribute to *The Second Century of Experimental Psychology* (2079) may even be spending most of their time in the sunlight.

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2 Social and Intellectual Origins of Experimental Psychology

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I. INTRODUCTION

When Wilhelm Wundt established the first formal, continuing laboratory of psychology at the University of Leipzig in 1879, that date and that laboratory provided experimental psychology—indeed, scientific psychology—with what was to become a memorable marker: They specified the date from which the emergence of the new profession could be followed; they pointed to the person whose views catalyzed psychology's most important debates during its first decades as a professional discipline; they indicated the place where many of the earlier, significant figures in experimental psychology got their training directly, or indirectly as pupils of those who had studied under Wundt; they announced the setting for a journal devoted to a new movement; they proclaimed the legitimacy of a new science through the focus on the concrete symbol of high science—the laboratory. No mean accomplishment for what was started in one room in an old building by a professor of philosophy.

Today, the term experimental psychology signifies a good deal more than the doing of psychological experiments. Therefore the date for the discipline's beginning could be set back long before 1879. Just how far would depend on the earliest date one could point to for a genuinely informative, empirical investigation. In any case, if it were mainly the performance of experiments or the devising of experimental methods, then surely Gustav Fechner, as G. Stanley Hall (1912) suggested, should be acknowledged as the founder of experimental psychology; in that case the significant date would probably be 1851, when the mystical *Zend-Avesta,* which first revealed his ideas, was published, though a less painful date for psychologists would probably be 1860, when the more conventional *Elements of Psychophysics* appeared.

This is the decision we would make if we heeded Wundt's own criteria for a scientific psychology. In the introduction to the complete version of his first book in 1862, *Contributions to the Theory of Sense Perception,* Wundt asserted that just as the course of progress in the natural sciences was tied to the development of methods of investigation, so would this have to be true for psychology. He argued that for psychology to become an explanatory science, as contrasted with a purely descriptive enterprise such as philosophical psychology was at that time, experiment would have to be added "to the internal observation which, alone, gives description only (Ribot, 1885)." Experimentation in its turn requires measurement. So, quite early, he had formulated for psychology the ideals that have become the guidelines for today's psychology: instrumentation, rigorous procedures, measurement, and, above all, empirically relevant concepts. Psychology—science—Wundt said, was defined by its methods. Because no one could dispute the fact that Fechner had invented and regularized the first genuine, and still powerful, psychological methods, we would be led by Wundt to proclaim Fechner as the founder of experimental psychology.

There are others, even more in the mainstream of psychology's development than Fechner, who might be considered as founders. Franciscus Donders, in his development of the reaction-time or mental chronometry methods in the 1860s (see Brožek, 1970, for a discussion of dating Donders' work), paralleled Fechner in devising a set of procedures and concepts that came to share the domination of topics and procedures in Wundt's laboratory. Indeed, in the past decade, Donders' methods have become both an essential tool and topic in the information-processing approach to psychology and have acquired renewed theoretical significance just as interest was reawakened in Fechner's contribution through the New Psychophysics (see Hochberg, Chapter 3, and Posner & Shulman, Chapter 9, this volume).

Or one could point to Ewald Hering, who, much like Donders, now looms larger in the history of psychology as his ideas and methods acquire more and more contemporary interest (Hurvich, 1969). Though a few years younger than Wundt, Hering published his work on the senses before Wundt. What is of greater significance is that he maintained his role as a laboratory scientist and continued his empirical work on perception at a level that was clearly deeper and more creative than anything Wundt had done as an active scientist. But if one lists Hering, how can one omit Hermann Helmholtz? He devised the reaction-time experiment that Donders adapted; he developed the modern science of hearing and vision by his own work and writings more than any other person, including Hering.

Finally, one cannot ignore Francis Galton, whose originality and marvelous versatility were already on view by 1869, when he published "Hereditary Genius."

No matter! There are too many candidates, all extraordinarily qualified, for an honor that has no generally accepted criterion. Fortunately, historians

of science are not an awards committee that must choose a single person as the year's first among equals. It is enough, as they seek to uncover the reasons for any person's selection, to be able to endorse or overturn the judgments rendered in an earlier time.

II. THE SOCIAL CONDITIONS OF PSYCHOLOGY'S RISE

There is little to be gained from arguing that some one person was *the* founder of experimental psychology. We do well to accept the plural noun in the title of G. Stanley Hall's book of 1912, *Founders of Modern Psychology,* as the best guide to assigning the responsibility for the start of psychology as a discipline and profession. We need not accept Hall's selections, though his inclusion of Fechner, Helmholtz, and Wundt (the others were Zeller, Lotze, and von Hartmann) covers at least three of the main characters in any account. But the nature of the new discipline cannot rest exclusively upon the persons involved. There must have been more than personalities at work. Experimental psychology arose almost completely in one country—Germany; it was transported to another land—the United States—where it flourished and practically became an American science (and still is, if one uses the criterion of the number of persons professionally identified as experimental psychologists; Americans exceed by far the total number in the rest of the world). What were the circumstances that favored Germany as the place where experimental psychology could emerge as an academic and professional discipline? Why did the United States pick it up so readily? How was the kind of psychology that arose in Germany related to the intellectual traditions of the German-speaking world? What was there about England, France, Holland, and even Italy, with their glorious traditions of science in mathematics, physics, astronomy, biology, and chemistry, that blocked or inhibited psychology's development? One can't help noting that the Rhine and the Channel have proved to be powerful, if not absolute, barriers to culinary and other intellectual influences as well as to military invasions; were the distinctive paths taken by experimental psychology in France and England, since the end of the nineteenth century, also the result of those natural boundaries?

In his *Principles of Psychology,* William James put forth a half-humorous suggestion about what made Germany the logical, inevitable place for the beginning of a modern, scientific psychology:

> Within a few years what one may call a microscopic psychology has arisen in Germany, carried on by experimental methods, asking of course every moment for introspective data, but eliminating their uncertainty by operating on a large scale and taking statistical means. This method takes patience to the utmost,

> and could hardly have arisen in a country whose natives could be bored. Such Germans as Weber, Fechner, Vierordt, and Wundt obviously cannot; and their success has brought into the field an array of younger experimental psychologists, bent on studying the *elements* of the mental life, dissecting them out from the gross results in which they are embedded, and as far as possible reducing them to quantitative scales. The simple and open method of attack having done what it can, the method of patience, starving out, and harrassing to death is tried; the Mind must submit to a regular *siege,* in which minute advantages gained night and day by the forces that hem her in must stir themselves up at least into her overthrow. There is little of the grand style about these new prism, pendulum, and chronograph-philosophers. They mean business, not chivalry. What generous divination, and that superiority in virtue which was thought by Cicero to give a man the best insight into nature, have failed to do, their spying and scraping, their deadly tenacity and almost diabolic cunning, will doubtless someday bring about [James, 1890, pp. 192–193].[1]

And so they did, as history shows. Against James' hopes, these people did make a science. Not that they did it by themselves, or that the psychology that developed was only their kind. There were soon to be (or already were in nascent state) psychologies of animals, thinking and learning, social behavior, development, and personality, as well as psychologies applied to education, psychopathology, and industry and commerce. But the academicizing of psychology was beyond a doubt the work of these Gelehrter.

Now, was it really, as James put it, a matter of personality? Of the Germanic character? I think not, attractive as the witty picture James painted may appear on first reading and though it appealed to all sorts of stereotypes and prejudices about Germany. That is not to say that the personal qualities of these scientists were irrelevant. That cannot and never could be true. But how such an elegant writer as James could ever describe Weber, the Fechner who created the pseudonymous Dr. Mises (Boring, p. 278), Helmholtz, or, indeed, Wundt[2] as unborable is astonishing. What we know about these

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[1]This statement by James was revived for me by seeing it quoted in Weyant's fine review (1968) of G. W. Allen's biography of William James.

[2]Wundt is a particularly interesting case. For many years it was puzzling to me how Wundt could have achieved so significant a role at Leipzig and in psychology. The standard characterization of him by, for example, G. Stanley Hall and Boring, makes him out to be an enormously industrious scholar, an extremely erudite, thorough, interesting, but not inspiring lecturer and author and, in general, a pleasant but typically preoccupied, traditional German professor. That picture does not fit with the fact that he became an academic and intellectual focus for German and foreign students who then went forth to establish their own laboratories in his model. Surely it would have taken a more exciting and dynamic person than what tradition has made Wundt out to be, to acquire such influence.

Dr. Kurt Danziger (1973) in his tremendously important study of German psychology, has provided a rather different and more useful characterization, based in part upon Wundt's autobiography. Wundt began that autobiography by an account of his political life, which