

THE
EXPERIMENTAL
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SERIES

CHRONOMETRIC EXPLORATIONS OF MIND

The Third Paul M. Fitts Lectures

MICHAEL I. POSNER



Chronometric Explorations of Mind

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Preface

Graduate school is an exciting time of life. For most, it is the first time one feels a part of what is a vast effort devoted to collecting, understanding, and transforming knowledge. At the time of my graduate training, a group of psychologists at the University of Michigan under the leadership of Paul M. Fitts was trying to discover a unity underlying studies of the human mind.

Different schools with their own questions and methods were busily engaged in the study of psychology. Behaviorists explored the nature of reinforcement, usually following the work of Skinner, but sometimes of Guthrie, Hull, Tolman, or another of the behavior theorists of the time. Those influenced by the computer developed programs capable of solving complex problems such as those found in symbolic logic. There was a great interest in the nature of language and the underlying grammar from which it is derived. Sensory psychologists were influenced by the growth of knowledge about the physiology of sense organs, and classical psychophysics was being enlarged by the scaling ideas of Stevens and the detection ideas of Tanner and Swets. Mathematical formulations of learning and decision making were emerging from laboratories at Michigan. Physiological psychologists were pushing electrodes deep within the brains of rats and discovering sites that would lead rats to work for stimulation and other sites they would work to avoid. It was an exciting world. Only rarely did psychologists attempt to find unity in this diverse activity, but the efforts of Hebb (1949) and then of Broadbent (1958) to do so made a profound impression on our group. We did not have the techniques needed to explore Hebb's ideas, but Broadbent's were something else again.

Our group was somewhat embarrassed by this rich corpus of material. Fitts set as his goal the development of a performance theory that would unify this

complex field, at least insofar as it applied to the performance of people in real-life tasks. We were not to deny any of these insights but rather to find a unity that would handle them all. On every side we found specialists making discoveries in isolation from one another, all determined to explore their own special fields. Perception, learning, memory, sensation, and skill were fields of study in which one majored and did one's work. Lesions, rote learning, straight alleys, tachistoscopes, and computers were the tools of the trade. They defined the problems that would be investigated and delineated the literature that would be appropriate.

Fitts' work was similarly shaped by a set of problems and a methodology. He took his problems from the things people did in working environments: driving automobiles, reading, listening to words in noise, etc. He used the methodology of careful, empirical measurements of time. His thinking was heavily influenced by the new metrics made available by information measurement, allowing us to combine such independent manipulations as number of events, their probabilities, sequential dependencies, and instructions given to people to stress speed or accuracy. He was struck with how well people could adapt to new situations and also with how rigidly they often carried forward inappropriate habits learned outside the laboratory.

As I began to develop a line of research work of my own, I became intrigued by the speeded methods I had learned to use from Fitts. Why did they work so well? Could it be that their ability to provide useful measures of performance revealed a fundamental fact about the nature of mind and its relation to brain? I came to believe that the answer was yes and that it might be possible to achieve a unification of different strands of the study of mind and brain by their systematic application. The type of unification sought was not to reduce one field of investigation to another, but to find methods that would allow their discoveries to converge on common models. In so doing, I departed considerably from Fitts' fascination with naturalistic tasks but retained his methods and his pursuit of knowledge via empirical generalization rather than simulation or speculative theory.

Some of the results of my 15 years of effort along these lines are contained in the following pages. They clearly do not qualify as a theory of mind. I have tried to avoid tempting extrapolations to problems that I have not specifically studied. Nor is this a textbook that reviews and critiques the results obtained in a given field. I have elsewhere attempted to integrate my results with others in the form of textbooks. But this is a personal statement of my own convictions and, more than that, of the evidence upon which they are based. I would not have had the nerve to impose it upon others without the explicit encouragement of the committee charged with these lectures—that in their view it could serve some useful purpose. The best that I hope is that these pages will provide a sufficiently encouraging picture of our ability to study the workings of mind to facilitate and not inhibit future efforts to realize the unified theory toward which Fitts labored.

In addition to Professor Arthur W. Melton and the committee sponsoring the Fitts lectures, I would like to express my appreciation to a number of other individuals and institutions who helped make it possible for me to carry forward this research. The majority of the studies reported here were supported by a series of National Science Foundation grants to the Universities of Wisconsin and Oregon. For more than 10 years, my colleagues at Oregon, and in particular Professors Steven Keele and Ray Hyman, have spent endless hours contributing to my education. Many students and colleagues were involved in aspects of the research reported here, and I have tried to acknowledge their individual contributions in the references cited. It remains to thank them collectively for their assistance in this work, which is so much a collective enterprise. A number of colleagues were kind enough to comment on an earlier version of the manuscript. In particular, I am grateful to W. R. Uttal for exceptionally detailed comments. The preparation of the manuscript for publication was aided by Marge Eldridge and Joyce Mills, as well as my wife, Sharon.

Eugene, Oregon

MICHAEL I. POSNER

Chronometric
Explorations of Mind

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1

Mental Chronometry

LANGUAGES OF MIND

Psychology is a discipline that can be approached from many different starting points. In particular, the study of mind can be viewed from the position of self-awareness (introspection), neural activity, or behavior (performance). Each standpoint gives rise to a particular language and set of methods. Although each language has its own unique advantages and disadvantages, it is a theme of this book that a common set of methods can serve as a basis for observations that tend to unify these different languages. In this chapter I seek to inform the reader about these methods and to indicate how they relate to the languages in which mind is usually discussed.

Introspection

The systematic experimental study of mind is 100 years old. It began appropriately with the method of introspection. All people have a window on the operation of their own minds available to them alone.

Psychologists sought to train systematic verbal reports based upon such introspections.¹ They hoped that from such systematic observations would come a

¹The term *introspection* as used here includes all efforts to use reports based upon the experience of the subject. Of course, different theorists had rules for what could be allowed as systematic introspection and what would be considered as naive. I do not wish to distinguish between introspections based upon systematic training in a theory and those of naive observers who might be induced to speak aloud as they solve problems or make judgments. They are both based upon the phenomenal experience of the judge. The term *phenomenal* will be used in the same way as *introspective*.

precise description of internal mental operations involved in our knowledge of the world. The method of introspection was used by “structuralists” not only because of its potential power as a tool to reveal mental processing, but because psychology was defined in terms of processes of which one could be aware. As a “science of conscious mental life,” psychology was confined to processes that could be made available to introspection. Thus two of the early theorists in the field, Wilhelm Wünder and Franz Brentano, in arguing the fundamental nature of psychology dealt with what processes could be brought to consciousness. Wünder argued that mental structures could be made conscious but that mental acts could not; Brentano argued the reverse. For Brentano, structures were unconscious and therefore amenable only to physiology, whereas mental acts alone were available to introspection and thus were the true subject of psychology. Wünder and Brentano agreed that the definition of psychology was limited to the study of those things that were conscious.

The revolutions in thought introduced by Darwin and by Freud showed clearly that a science based only on conscious content would miss much of what is vital in human life. The evolutionary continuum between humans and other animals emphasizes the adaptive significance of a brain that has evolved not to underlie the introspective mental life of philosophers but to produce actions and thus survival in the environment (Jerison, 1973; Razran, 1971). Freud popularized the idea of the unconscious and forced acceptance of the view that unconscious motives were a significant factor in the explanation of human behavior.

Thus introspection had serious problems both as a technique for the investigation of mind and as a definition for the field of psychology. But the failure of phenomenology and introspection as complete techniques for the study of mind and as a definition of the field should not be interpreted as meaning that introspective reports are unimportant. Current objective psychology relies a great deal on introspective reports of the subject. For example, modern psychophysics requires observers to introspect about the nature of their sensory experiences. These introspections are standardized by requesting such operations as matching or assigning numbers to indicate perceived intensity. Nonetheless, psychophysics is based on the conscious introspections of normal human subjects and depends upon the commonalities present in such introspections. Its success surely gives the lie to claims that introspection cannot provide systematic, quantitative, and reliable data but gives no assurance that introspections will be sufficient by themselves.

Similarly, much recent work on problem solving relies heavily upon the use of introspection through the method of speaking aloud (Newell & Simon, 1972). Subjects speak aloud during the process of solving a problem, and the investigator seeks to develop a computer program that mimics the protocol provided by them. This technique bases theories of problem solving upon those processes that are easily available to the conscious introspections of the subject. Although