Philosophic Foundations of Genetic Psychology and Gestalt Psychology

A Comparative Study of the Empirical Basis, Theoretical Structure, and Epistemological Groundwork of European Biological Psychology

by

ASH GOBAR

MARTINUS NIJHOFF / THE HAGUE

This treatise is intended for the students of Philosophy and Science primarily (and secondarily for the students of the Humanities).

The author's conception of the *philosophy of science* as the 'morphology of science' (rather than the popular 'grammar of science') involves the adoption of a double-perspective which is reflected in the two phases of this work:

(I) The scientific assessment of the experimental phenomena of Biological Psychology (especially the genetic and gestalt psychologies).

(II) The logical analysis of the methodological and epistemological framework of Empirical Psychology (as a member of the family of the Biological Sciences) in general.

Among the *special features* of this book the following may be noted:

(1) A systematic review of the varieties of experimental studies in Biological Psychology supplemented with commentaries.

(2) Dispelling the prevalent misconceptions and spurious criticisms of European Psychology (especially the genetic and gestalt trends) by returning to the original sources of evidence (cf. the General Bibliography).

(3) Indicating, wherever possible, lines of rapprochement between the European and the American psychologies.

(4) Original contributions, supplementary to the genetic and gestalt theories, notably in the morphological sketch of thought processes.

(5) Outlining the prolegomenon to a realistic philosophy of science (especially biological sciences) in which the principle of methodological complementarity and the concept of phenomenological spectrum play special rôles.

"This field of enquiry, in which philosophers have as yet not shown much interest, is dealt with very ably and fully by Dr. Gobar," writes Dr. Wolfe Mays (cf. *Introduction*), Senior Lecturer in Philosophy of Science in the University of Manchester, "A very important part of this book contains Dr. Gobar's views on the philosophy of science in which he develops some interesting concepts. These connect his discussions of the empirical psychological data with philosophical theorizing. We may specifically mention here, (*a*) that of the phenomenological spectrum and the hypothesis of levels, and (*b*) his general conception of the philosophy of science as the morphology of science."

About the author: His qualifications include a double background in Science (M.Sc.-Equivalent in Biological Psychology) and Humanities (M.A. in Intellectual History) besides Philosophy proper (Ph.D. University of Wisconsin, 1959). Born in 1930 in European Georgia, he received all his higher education in America, excepting an interim in Europe. His dissertation on Abstract Entities was a study in the logic of sciences. Awarded a Research Grant by the National Institute (U.S.A.), for the writing of this treatise, he was a Travelling Fellow in the Université de Genève (Institut J.-J. Rousseau) (1959–60), and subsequently, a Visiting Scholar in Columbia University (1960–61). Lately, Associate Professor of Philosophy & Psychology in Concord College and the University of Hartford, he holds the same position in Transylvania College presently.

1968. XXVIII and 331 pages. Guilders 40.25

DENNIS N. K. DARNOI

The unconscious and Eduard von Hartmann

A historico-critical monograph

1967.V and 198 pages. Guilders 23.40

*

P. A. HEELAN

Quantum mechanics and objectivity

A study of the physical philosophy of Werner Heisenberg

1965. XV and 207 pages. Guilders 27.—

*

WILLIAM M. JOHNSTON

The formative years of R. G. Collingwood

1967. XIII and 167 pages. Guilders 25.20

HAIG KHATCHADOURIAN

A critical study in method

1967. XIV and 254 pages. Guilders 28.80

*

LAUCHLIN D. MACDONALD

John Grote

A critical estimate of his writings

1966. XXI and 284 pages. Guilders 38.50

*

LAZARE SAMINSKY

Physics and metaphysics of music and essays on the philosophy of mathematics

A green philosopher's peripeteia. Physics and metaphysics of music. The roots of arithmetic. Critique of new geometrical abstractions The philosophical value of science

1957. 151 pages. Cloth. Guilders 10.45

*

VINCENT VYCINAS

Greatness and Philosophy

An inquiry into Western thought

1966. XI and 294 pages Guilders 34.75

*

JOHN W. YOLTON

The philosophy of science of A. S. Eddington

1960. XV and 151 pages. Guilders 11.50

One guilder = ab. $ 0.28 = ab. 2 sh. = env. Ffr. 1.36 = ca. DMW. 1.10

Obtainable through any bookseller or directly from the publisher

PHILOSOPHIC FOUNDATIONS OF GENETIC PSYCHOLOGY AND GESTALT PSYCHOLOGY

PHILOSOPHIC FOUNDATIONS OF GENETIC PSYCHOLOGY AND GESTALT PSYCHOLOGY

A Comparative Study of the Empirical Basis, Theoretical Structure, and Epistemological Groundwork of European Biological Psychology

by

ASH GOBAR
Dr. of Phil.

Associate Professor of Philosophy & Psychology
Transylvania College
Sometime Fellow of the National Institute
U.S.A.

with introduction by

WOLFE MAYS
D. Phil. (Cambridge)

Senior Lecturer in Philosophy of Science
University of Manchester
England

MARTINUS NIJHOFF / THE HAGUE / 1968

ISBN 978-94-015-0287-0 ISBN 978-94-015-0813-1 (eBook)
DOI 10.1007/978-94-015-0813-1

Dedicated to

William James
(1842–1910)
the founder of Systematic Psychology
and the forerunner of Phenomenology
in America

ACKNOWLEDGEMENT

The writing of this treatise has been honoured by a grant from the National Institute (N.I.M.H. Postdoctorate Research Fellowship 1959–61). This grant, besides being financial subsidy, bestowed an acedemic freedom which provided the optimum psychological context for creative research.

The author remains indebted to the Institut J.-J. Rousseau of the Université de Genève where, during the year of his residence as a Travelling Fellow (1960), Prof. Jean Piaget, and the members of the Centre d'Épistémologie Génétique, discussed with him the theoretical problems of genetic psychology, and Dr. G. Noelting kindly made available the results of his "longitudinal studies."

The author is grateful to Columbia University for having extended to him the special privileges of a Guest Scholar (1961), during the second year of the research, when the main draft of the work was written. And the author must express here his ancient gratitude to the Departments of Psychology and Philosophy of the University of Wisconsin.

The names of the thinkers whose writings have been a special source of inspiration to me may be recorded here. The writings of Wm. James, W. Köhler, J. Piaget, F. J. J. Buytendijk, B. Rensch, N. Tinbergen, and E. G. Boring in psychology and biology. And, in philosophy, German Phenomenology (especially N. Hartmann and E. Cassirer) and American Realism (especially A. N. Whitehead) as well as some of my contemporaries in the phisolophy of science.

May this treatise prove worthy of the faith placed in it by my friend, Wm. G. Morrison, whose early death deprives it of its oldest patron.

Martinus Nijhoff N.V., where Craftsmanship is valued above all, has saved this work from Compromise.

ACKNOWLEDGEMENT TO PUBLISHERS

The following publishing companies have generously granted the author permission for brief citations and illustrations from their publications (cf. Bibliography):

Presses Universitaires de France, Paris, France.
Springer Verlag, Heidelberg, Germany.
M. Nijhoff N.V., The Hague, Netherlands.
Routledge & Kegan Paul Ltd. (International Library of Psychology and Philosophy), London, England.
Columbia University Press, New York, New York.
Yale University Press, New Haven, Connecticut.
University of Chicago Press, Chicago, Illinois.
University of Wisconsin Press, Madison, Wisconsin.
Stanford University Press, Stanford, California.
Basic Books Inc., New York, N.Y.
Doubleday & Co., New York, N.Y.
Dover Publications Inc., New York, N.Y.
Henry Holt & Co., New York, N.Y.
Humanities Press Inc., New York, N.Y.
Alfred A. Knopf Inc., New York, N.Y.
Macmillan Co., New York, N.Y.
Principia Press Inc., Bloomington, Indiana.
C. C. Thomas Co., Springfield, Illinois.
J. Wiley Inc., New York, N.Y.

CONTENTS

INTRODUCTION

In this highly interesting and valuable study, Dr. Gobar is concerned with a very important problem, namely, how far are empirical questions of psychology relevant to philosophical questions of perception, intelligence and thought. He points out that just as psychologists ought to take into account the philosophical foundations of their science, so philosophers ought also to realize that psychology as a science has significant implications for philosophy and its problems. Philosophers, he goes on, endlessly discuss questions relating to perception, consciousness, memory, imagination, habit, emotions and personality, without any reference to the results of psychological research, some of which are highly relevant to their discussions. Dr. Gobar's remarks apply particularly to philosophical studies of perception and thought. In these fields the results of Gestalt and Genetic Psychology have brought to light a wealth of relevant data.

Gestalt Psychologists have shown that we see things as organized wholes rather than as a succession of sense-data. They have emphasized that what we actually see is in no way a copy of what occurs on our retinae, and have exhibited the inadequacies of the philosophical sense-datum theory. According to this theory, what one ought to observe if one walks around a circular coin is a series of elliptical sense-data varying according to the laws of geometrical optics. However, as Gestalt Psychologists have abundantly demonstrated, what one actually observes is that the coin tends to look circular from most angles.

Philosophical studies, especially, in the field of perception often continue as if no advance had been made since David Hume. In accepting Hume's doctrines these philosophers also implicitly accept the eighteenth century Newtonian world-picture of things, which seems to be inherent in much of Hume's thinking, and which is a physical correlate of his account of perception. When Hume talks of the way in which impressions and ideas are combined, he refers to association as a gentle force and explicitly compares it with gravitation. The Gestalt

Psychologists have, however, shown that what we are primarily aware of is not a succession of sense-data but figures-ground phenomena: Wittgenstein's ambiguous duck-rabbit is merely one such example. They have also drawn our attention to the existence of tertiary qualities in perception, such as 'symmetry' and 'elegance' which are just as directly given as are the perceived colours red, green or yellow. It is interesting to note that Merleau-Ponty has made considerable use of Gestalt ideas in his Phenomenology of Perception.

One of the commonest reasons given by linguistic philosophers for not making direct use of the results of psychological research (although philosophers are usually willing to accept the first-hand results of physical science) is that philosophical accounts of perception and thinking are concerned with analysing the language in which these reports are made; that is to say, they are second-order enquiries. Often this approach is still more restricted and ordinary linguistic usage is taken as the yardstick against which questions relating to thought and perception are to be measured. The task of the philosopher is then confined to the analysis of ordinary language. If he is more adventurous, as some writers on philosophical psychology are, he might go on to show how far the language used by psychological researchers falls short of the paradigms of common sense.

On the linguistic view the business of philosophy is not to tell us what we 'see,' 'hear' and 'touch,' but to map out the different ways in which words like 'see,' 'hear' and 'touch,' are legitimately used, and to indicate the rules which govern the use of such verbs as 'to think,' 'to imagine' and 'to infer.' In short, it is argued that if we really want to come to grips with the philosophical problems of perception and thought, we ought to investigate the complex vocabulary of 'perception' and 'thought' in ordinary language.

There is hence no need to consult the experimental psychologist; everything the philosopher requires for his analyses is already contained in that rich repository of words and ideas—The Oxford English Dictionary. Dictionaries, often, however, show a considerable time-lag between their recording of technical expressions, and the first appearance of these expressions in scientific thought. We know that the advance of psychological science has led to the inclusion of such entries as: 'Oedipus complex,' 'sublimation' and 'conditioning.' Philosophers ought then to take note in their theorizing of the relevant psychological work when it is still fresh, and before it has become embalmed in the form of dictionary definitions.

Further, common-sense of which ordinary language is usually the expression, has not always been a reliable guide in physical science; one need only mention the terrocentric hypothesis and Aristotelian physics; it is also questionable whether it is a certain guide in the mental realm. One must remember that much of ordinary linguistic usage reflects an outdated scientific world-picture, a very Aristotelian one of matter and mind, which usually lags behind informed scientific opinion. If physicists had to study physics by means of ordinary language without technical terms or the use of mathematical contructions, physics might still be where Aristotle left it.

Some philosophical discussions of perception and thought still remain at the stage they were before psychology became an empirical science, and where introspection was the sole method employed in the description and analysis of mental phenomena. But have we any grounds today for assuming that our unaided personal observations are incorrigible, as Descartes, for example, thought in the case of the *Cogito*? It is true, however, that in recent years some philosophers have appealed to behavioural skills, rather than to introspections when discussing perception and thought. Nevertheless, most of their accounts are highly impressionistic and are not subject to experimental control or verification. The skills referred to are usually motor ones, such as riding a bicycle or those involved in playing games like tennis, and are described in ordinary language. The main object of these accounts seems to be to attempt to reduce by analogical reasoning higher-level intellectual skills to lower-grade motor skills, hoping in this way to exorcise 'the ghost in the machine.' In discussing intellectual skills, for example, there is little or no reference to empirical studies on concept formation, especially as these studies show that the higher-level skills are not thus simply reducible.

This field of enquiry, in which philosophers have as yet not shown much interest, is dealt with very ably and fully by Dr. Gobar. As he indicates, Piaget's work is here of major importance and has far-reaching consequences. Piaget has shown that the concepts of logic, space, time, quantity and number, which are central to much of modern scientific thought, are not as Kant endeavoured to demonstrate, *a-priori* categories of mind in terms of which our experience is ordered. He points out that even such fundamental categories as the principle of identity, do not appear in child thought until such concepts as 'weight,' 'volume,' and 'shape' have been formed at a relatively late age, usually at about *7* or *8*.

Many philosophers, on the other hand, have assumed an immediate intuitive awareness of universals without any learning process entering in. Piaget's work shows that no such reflective intuition of universals is to be found at these early ages. He has also shown how these concepts occur first of all in a concrete behavioural form when the child manipulates objects, before they begin to exhibit themselves on an abstract propositional level.

Piaget's results seem to run counter to the fashionable philosophical view that concepts cannot exist without language. He has demonstrated that the child at a certain age can classify and serialize objects on a concrete behavioral level before he can perform verbal reasoning. Thus he can serially order three sticks of different lengths, although unable to solve this problem on the plane of verbal reasoning. On the other hand, he may be able to count verbally from *1* to *10* without having an adequate concept of number: he may, for example, be unable to set up a one-one correspondence between two groups of objects, each having the same number of objects but arranged in a different spatial manner. In the new forms of teaching school-arithmetic this insight has been made use of and emphasis has been put on the learning of number by the child actually performing concrete operations, rather than through verbal counting.

Philosophers often say that the view that concepts are constructed is based on a muddled conception of abstraction. This may be the case with Locke's and J. S. Mill's views, but considerable advances have been made since then in the experimental study of concept formation, and constructionist views, as Piaget's work shows, have taken on a more precise and sophisticated character. The problem one is faced with is whether it is better to accept as many philosophers do, a clear but nevertheless, highly ideal theory of universals, rather than a constructionist theory, which admittedly lacks the latter's clarity. Despite the somewhat approximate and provisional character of constructionist theories, they seem, however, to be in closer agreement with the methods and results of science, which are always subject to revision.

As Piaget points out, the strength of the Platonist position, is that it suppresses the difficult problem of the construction of concepts. On this view we discover logico-mathematical concepts instead of constructing them. But this is counterbalanced by the difficulties raised, since logic and mathematics are made to correspond to a static world of timeless universals independent of us. An appeal to logical criteria cannot help us to solve the problem of the existence of this world, as questions of ontology lie outside the scope of logic.

A Platonic theory of universals has undoubtedly its appeal, as it seems to make philosophy independent of any empirical reference, but as Kant has shown, from the fact that such a realm of entities is conceivable one cannot go on to argue that it necessarily exists. Nor can logical principles be taken as prescribing the range and variety of possible experiences; a major characteristic of science is its openness to new kinds of experience.

A very important part of this book contains Dr. Gobar's views on the philosophy of science in which he develops some interesting concepts. These connect his discussions of the empirical psychological data with philosophical theorizing. We may specifically mention here, (*a*) that of the phenomenological spectrum and the hypothesis of levels, and (*b*) his general conception of the philosophy of science as the morphology of science.

According to (*a*), nature exhibits various realms having various qualitative features and located at different phenomenological levels: to these levels correspond the various natural sciences. Examples of such phenomenological levels are the microscopic and the macroscopic levels of physics, the integrative levels of biology; in psychology, human nature as a physiological system and as a psychological system. These levels exhibit relationships to each other of continuity and divergence. An example of biological continuity may be seen in the case of vegetative animals and carnivorous plants. Divergence is exhibited in the appearance of novel traits in higher levels; for example, the phenomena of psychology and biology are transcendent to the analytical framework of physics. Although there are partial parallels, the natural laws applying to the objects of the biological sciences are then logically different from the laws applying to the objects of the physical sciences.

He also distinguishes between ontological levels and epistemological levels. The former are the levels of natural phenoma taken by themselves as objects of natural science; the latter the levels of our conceptual knowledge of these objects. For example, in the case of physics the epistemological level of our knowledge will be more complex than in psychology. Our knowledge of psychological objects is immediate, whereas our knowledge of physical objects is mediate and dependent on the former.

As far as (*b*) is concerned, he regards philosophy of science as having a two-fold objective, (1) the examination of the phenomenological varieties of the sciences and (2) the examination of their logical structure. He is critical of physicalism's attempt to achieve the unity of science by reducing higher to lower levels. Instead, Dr. Gobar emphasizes the diversity of the data of the natural sciences in contrast to the unity of their logical form. He conceives the morphology of science as the systematic integration of the phenomena of the various sciences within a realistic theoretical framework.

It is to be hoped that philosophers as well as psychologists will read Dr. Gobar's work. I am sure that they can learn some valuable lessons from the way he has been able to bring together empirical psychological data and philosophical theorizing and show their mutual relevance. As Wittgenstein once said paraphrasing Kant, "One cannot philosophize on an empty stomach." And this is particularly the case when we deal with epistemological problems, which at every turn raise psychological as well as formal problems.

Wolfe Mays
D.Phil. (Cambridge)
Senior Lecturer in Philosophy of Science
University of Manchester
England

PREFACE

The fundamental contributions of European universities to academic psychology, in contemporary times, have consisted of the formation and transformation of four general trends. These include Gestalt Psychology (of which the German Phase and the American Phase have become closely intertwined), Genetic Psychology (comprising the School of Geneva, the Ganzheitspsychologie, and the School of Utrecht), Ethological Psychology (closely affiliated with comparative biology in Germany and England), and lastly, the Soviet School of physiological psychology. The main objective of the present treatise is to provide a comparative study of the empirical basis and theoretical structure of genetic psychology relative to gestalt psychology with an investigation of their epistemological groundwork. Since these two schools are essentially concerned with the cognitive processes, the psychology of perception and thought shall constitute the main theme of this work. And since both schools are concerned with the epistemological problems, among other things, this treatise shall examine the philosophical foundations of empirical psychology in general.

Gestalt psychology has been given a critical hearing in the English-speaking world, however partially, much to the subsequent benefit of objective psychology, and it has taken a half-root in our scientific soil. It is timely, then, to examine the European genetic psychology, which is affiliated with the former, at the empirical as well as the theoretical level. It is now generally recognized that the empirical discoveries of genetic psychology have greatly contributed to our knowledge of the cognitive processes (regardless of their various implications for the applied "child psychology"). However, the theoretical system that lies behind these empirical phenomena, that synthesizes them and provides them with a logical explanation, has hardly been given the critical attention that it deserves. Since genetic psychology has adopted some of its fundamental concepts from gestalt psychology, and since both schools display a theoretical affinity, an understanding of the latter is necessary for the understanding of the former. In any case, in view of the persistent misinterpretation of gestalt psychology by its critics, a theoretical restatement of its basic ideas remains a necessity. This is especially the case, since the contemporary renaissance of functional psychology in America, which has transcended the narrower framework of behaviorism in many respects, and which has incorporated many experimental and theoretical results of gestalt psychology, has provided an objective framework within which the tenets of gestalt psychology find at least an objective verification.

The title of this book, "Philosophic Foundations of Genetic Psychology and Gestalt Psychology," stands in need of explication.

"Genetic psychology" in this book refers, without qualification, to the European genetic psychology. This psychology being the subject-matter of this work, the sundry references to the American genetic psychology, referred to as such, will be solely for the sake of comparison and contrast. European genetic psychology consists of three main phases, all phases bearing essentially the same family resemblance to gestalt psychology. The German Phase has been developed by Wilhelm Preyer, W. Stern, O. Kroh, F. Krueger, H. Werner, the Bühlers, and H. Thomae (Bonn). The French Phase has been developed by A. Binet, Pierre Janet, and H. Wallon (Paris); Édouard Claparède, Jean Piaget, and B. Inhelder (School of Geneva). Between these two phases, and relatively independent of both, stands the School of Utrecht whose senior psychologist, F. J. J. Buytendijk together with his colleague M. J. Langeveld, have provided us with an integrative genetic psychology (partially parallel to the "Genetische Ganzheitspsychologie" of the German Phase but essentially very original) with critical implications for the School of Geneva. The present work, being primarily concerned with the psychology of perception and thinking, is essentially a study of the French Phase (especially the School of Geneva) with comparative references to the German Phase and the School of Utrecht. However, it is not our objective to provide a complete introduction to the School of Geneva such as has been provided by its senior psychologist Piaget (1950) or by the corresponding compendium of J. H. Flavell (1963). The scope of our work is more general, as it were, being concerned with the comparative examination of genetic and gestalt psychologies relative to their theoretical foundations.

In the case of gestalt psychology no attempt will be made to separately treat of its two phases, that is, the German Phase and the American Phase. These phases are closely interwoven, in some cases the work that began in Germany being continued in America, and in other cases parallel developments forming in the two countries. The prolegomenon to *Gestalttheorie*, the roots of which go deep into German phenomenology, began with the descriptive study of "*Gestaltqualitäten*" by C. F. von Ehrenfels (1890), the significant result of which was the discovery of the phenomena of integration and transposition. However, the systematic founding of gestalt psychology took place as a result of the critical experiments by M. Wertheimer, Wolfgang Köhler, and K. Koffka at the University of Frankfurt (1912). To this distinguished group may now be added the names of: K. Lorenz (Königsberg and later Max Planck Institute of Comparative Ethology), E. Kretschmer (Tübingen), H. Rorschach, E. Oppenheimer, K. Duncker, Wolfgang Metzger (Münster), David Katz (Stockholm), K. Goldstein, F. Wulf, K. Conrad, E. Rubin (Copenhagen), E. Höhn (Tübingen), R. Bergius (München), J. Elmgren (Göteborg), H. Wallach (Swarthmore), S. E. Asch (Swartmore), R. Arnheim, K. von Fieandt, N. R. F. Maier, and Ivo Kohler (Innsbruck), who have contributed to the development of gestalt psychology along diverse lines. The biological and psychological work of F. J. J. Buytendijk (School of Utrecht), of which the theoretical scope extends beyond *Gestalttheorie* into phenomenology, unfolds a configurational dimension in the light of physiological analysis, and in this respect his name belongs in the history of gestalt psychology. Since general introductions to gestalt psychology have already been written, by no less authorities than Köhler and Koffka in America and in Europe by J. Elmgren and P. Guillaume, it will not be our objective to provide an introduction to this subject; but rather to trace the theoretical structures of gestalt psychology and genetic psychology, revealing their methodological and conceptual affinities, and demonstrating their logical consequences for a realistic interpretation of the philosophy of science.

There is a twofold relationship between gestalt psychology and genetic psychology, which in some respects strikingly resemble each other, and yet are fundamentally very different. On the one hand, gestalt psychology is logically prior to genetic psychology which derives some of its basic concepts from the former (e.g. "structure" and "equilibrium"); and on the other hand, the perspectives of the two schools are logically complementary. The methodologies of both schools indicate a special reliance upon qualitative experimentation; both are profoundly concerned with the problems of perception and thought processes; and both schools have significant implications for epistemology and the philosophy of science. The fundamental difference between these two schools lies in their perspectives. And this makes all the difference—in experimentation and in the results obtained, in the methods of investigation and in the problems set up for investigation. Gestalt psychology is profoundly concerned with the interaction of factors in a given psychological context. It pays attention to the object mainly in the specious present so to speak. Of course, it allows for the organismic variables operating in the subject, but it is inclined to accept the specific description of these factors given by others (e.g. functional psychology). It pays full attention to the subject's psychological set (*Einstellung*), but the set constitutes the startingpoint of gestalt psychology. There is a deep running ahistoricism implicit in gestalt psychology, and it comes to the fore in its field theory. The perspective of gestalt psychology is ahistorical, and this perspective renders it the antithesis of genetic psychology. The one perspective is almost entirely transverse, the other purely longitudinal. But this fundamental difference between their perspectives renders these two schools complementary.

Comparing the trends of genetic psychology in Europe and in America, as it will be apparent in the course of the present work, there is an essential difference between these two variations of genetic psychology. European genetic psychology employs qualitative methods of research; its approach is basically cognitive; hence its fundamental interest in the psychology of thought and of perception. And it collects experimental data with an eye on the psychological structures which are directly unobservable but which are assumed to lie beyond the data and behind the subject's overt responses. American genetic psychology, in contrast, employs mainly quantitative experimental methods. Its approach is functional, its objective being the determination of the correlation coefficient between the factors involved in observable phenomena. It gathers reliable data, statistically, with the calm expectation that, when there are enough facts gathered, they will themselves fall into classes and reveal patterns of behavioral evolution as a function of time. Thus American genetic psychology, for methodological reasons, contains a minimum of theory; while European genetic psychology, seeking a conceptual reconstruction of the covert processes underlying the overt phenomena, contains a maximum of theory. Hence, a fundamental concept like "operation" comes to acquire diametrically opposed meanings in the context of the two psychologies. The methodological approach of the American genetic psychology is commensurate with that of American psychology in general; while the European genetic psychology (in all its phases) bears a family resemblance to gestalt psychology. Both psychologies, of course, being genetic, have the great bond of the historical perspective between them, together with a partial methodological overlapping. And both have pedagogical implications in theory—although in practice these implications are far less heeded in America, where the gap between *theoria* and *pragma* is still great, than they are in Europe. Historically, the predominance of the behavioristic trend in America has resulted in the neglect of cognitive processes in general. Accordingly, when J. M. Baldwin's systematic treatise (23), with its purely cognitive prolegomenon to genetic psychology, appeared in this country (1906–11), before the awakening of the School of Geneva, it had a greater influence over European psychologists than over American psychologists. About the trend of American psychology in contemporary times (early 1950s) an European psychologist, Van de Geer (344: p. 5) of the University of Leiden, has observed: "Consulting the *Psychological Abstracts* one finds, from 1950 to 1954, 4471 publications on cognition in general, of which 64.3% deal with perception, 29.8% with learning and memory, whereas only 5.9% are devoted to thinking and imagination." This general picture of American psychology also holds true for American genetic psychology. Of course there have been some cases of cognitive studies in American genetic psychology, notably Russell's work (309), but these have been more the exception than the rule. And yet the basic psychology of thought processes, aside from its purely theoretical value toward the establishment of a psychological conception of man, is highly valuable for clinical psychology as well: For it is always easier to describe the deviations when the standard itself has been described clearly; and, consequently, advancements in the theory of thought processes in academic psychology will always have import for the theory of pathological thinking in clinical psychology. Thanks to the renaissance of functionalism in contemporary American psychology, there has been an awakening of a deeper concern for the psychology of cognitive processes. It is the farthest aspiration of this author that the present work, within its given framework, might seek to achieve a theoretical *rapprochement* between the modern trends of psychology in Europe and in America: To the extent that the methodological and epistemological problems, which are critically examined here, underlie the European psychology as well as the American psychology, this work is concerned with the theoretical foundations of both psychologies.

"Philosophic foundations," which appears in the title of this book, refers to those elements of a science which constitute the subject-matter of the philosophy of science. They consist of the basic concepts, methodology, and the logical framework of science. They appear to stand insoluble in the homogeneous medium of its "scientific content," and are revealed, by a philosophical analysis, to be a philosophical residuum. But since science has traditionally refrained from engaging in, philosophical introspection, science remains philosophically dogmatic. Contemplating this philosophical predicament of science, some philosophers of science have suggested that science should purge itself of its philosophical foundations immediately and completely; while others have held that science without theory, and theory without some kind of philosophical foundation, would be nigh impossible, and that, consequently, science must learn to resign itself to its philosophical nature. But it appears that the best alternative must lie in the synthesis of these antithetic prescriptions. Science may retain its philosophical foundations, but keep them under critical inspection. And this, of course, would require scientists to engage in philosophical speculation about their science, and to pragmatically open the door of the scientific laboratory to the philosophy of science. However, if such speculation contributes to a reorientation in theory, to the emergence of a new family of problems, and to the formation of a new set of hypotheses to be verified, if, in short, philosophical speculation results in theoretical and experimental reformation, then it will have been worth its price.

The students of philosophy must realize that psychology, as a natural science, bears significant implications for philosophy and its problems. The phenomena of European and American psychology, especially in the area of perception and thought, have a philosophical value: They provide an empirical ground of verification for the various epistemological theories. Gone are the days when the professional philosopher also professed to be a psychologist because psychology was considered to be a part of philosophy. But ever since psychology has left the hall of philosophy, professional philosophy has complacently resolved to do without psychology. Consequently, such topics as perception, apperception, consciousness, memory, imagination, habit, emotions, and personality are endlessly discussed in the halls of philosophy without any mention of the science of psychology and seldom with any knowledge thereof. And even if it be granted that a philosophical theory may be constructed independently of facts, we should nonetheless expect that the theory, after it is constructed, be able to explain the natural phenomena instead of being surprised by them! The least that the facts of psychology could do for philosophy would be to forestall its construction of factually defective theories. Philosophical studies, particularly in epistemology, cannot go on as if psychological research were irrelevant. Professional philosophers have often spoken of the "philosophical naïveté" and "philosophical embarrassments" of psychology; but the "psychological naïveté" and the "psychological embarrassments" of contemporary philosophy appear to be equally pervasive.

The material of this book falls naturally into two main parts: (I) *Structure of Genetic Psychology and Gestalt Psychology*. In this part a systematic and comparative sketch of the theoretical structure of gestalt psychology and genetic psychology will be presented. For the genetic psychology this will consist of a statement of its experimental and theoretical methodology consisting of the "psychogenetic method" (*méthode psychogénétique*) and the "operational logic" (*logique opératoire*) respectively; a description of its theory of perception and its relationship to the theory of thinking; an assessment of the representative cases in the long series of experiments, concerning the genesis of concepts and hypotheses, on the basis of which the genetic theory of thinking was constructed; and, finally, a systematic outline of the genetic theory of thinking, which, in its widest range comprises the genesis and transformation of the concrete and abstract operations of thought. The gestalt theory of perception and the gestalt theory of thinking, conceived in their contemporary forms, will be sketched for comparative study. If there be anything in this psychological part of the work, in which this author might lay claim to originality, aside from sundry things, then it is the morphological analysis of thought processes (cf. Chapter 6). The general perspective adopted in this descriptive part of the work will be that of psychology as a natural science. (II) *Philosophic Foundations of Psychology*. This part will consist of a methodological analysis of European psychology relative to American psychology; a logical analysis of the basic concepts of European psychology, specifically, the concept of "configuration" (*gestalt*) and of "abstraction"; an analysis of the epistemological foundations of the science of psychology; a comparative examination of the genetic theory of epistemology (*épistémologie génétique*) and of the gestalt theory of epistemology (*gestalt epistemology*); and, finally, the sketching of the principles of a realistic philosophy of science, on the basis of the objective evidence of empirical psychology as a natural science, which represents a viewpoint partially affiliated with the realistic trend in contemporary philosophy, and which constitues the main contribution of the author as an original reconstruction. In any case, the full comprehension and evaluation of European psychology necessitates the adoption of a double-perspective, that of natural science and that of epistemology, both of which are interrelated at the fundamental methodological level, and the author has strived to unfold the ramifications of this manifold interrelationship throughout the last chapters. On this basis the claim of this treatise to be a study in the philosophy of science in its authentic sense rests.

The intelligent student, seriously dedicated to psychology and philosophy, should be able to comprehend (if necessary upon repeated reading) the central ideas contained in the advanced chapters of this book. Generally speaking, the technical concepts of psychology and the philosophical terminology have been explicated in their respective contexts. The General Bibliography comprises three classes of works: The original sources in European genetic psychology and gestalt psychology; the experimental and theoretical studies in American psychology related to the former; and studies in the philosophy of science (especially the philosophy of the biological and psychological sciences). All the citations from the original sources in French and German, appearing in the text of the treatise, have been translated by the author.

After everything has been said, this work, the general objective of which is the achievement of a theoretical synthesis, remains limited in various respects, and no one will be more aware of these limitations than its author. May, then, others undertake what I have undertaken, and achieve a more perfect presentation in the future.

In this age of "big science," crowded by voluminous tomes and polyauthored papers, a book of modest volume by a solitary scholar, which aspires to treat of fundamental problems, must remain apologetically diffident. Yet the treatise has required five years for its writing. My courses on the "History of Psychology" as well as "Contemporary Philosophy," which have consistently claimed their portion of the time, have nevertheless contributed their select fragments of insight. Several books concerning related topics have already appeared since the inception of this work. It only remains for this author to derive some measure of consolation from the old German saying to the effect that: *Wer spät bringt wird etwas wertvoll bringen.*

August 1965

A. G.

Columbia University and
Concord College *U.S.A.*

PART ONE

STRUCTURE OF GENETIC PSYCHOLOGY AND GESTALT PSYCHOLOGY

CHAPTER I

HISTORY OF EUROPEAN GENETIC PSYCHOLOGY

In the context of natural science, phenomenology is based upon methodology, and methodology always has a scientific history. Therefore, this beginning chapter is being devoted to the historical aspect of European genetic psychology, and its various phases, but without attemptingto present a comprehensive history of the subject which falls outside the scope of the present treatise.

The trend of genetic psychology in Europe consists of three main phases: We shall refer to them as the *German Phase*, the *Northern Phase*, and the *French Phase*. Of these phases, despite partial parallelisms and overlappings in their development, the German Phase is the oldest and the most complicated in form. Since these phases bear fundamental relationships to gestalt psychology, in varying degrees, we have adopted the method of comparative analysis in our investigation of the theoretical structures of genetic psychology and gestalt psychology. And if we have concentrated mainly on the French Phase, in contrast to the German and the Northern phases, it is by no means that the former is more important than the latter in the context of psychology at large. Indeed, comparative and critical references will be made to the German and the Northern phases in our detailed examination of the French Phase. It is rather that the French Phase, like gestalt psychology to which it is profoundly indebted, is primarily concerned with the cognitive processes in the stricter sense; and the psychology of perception and thought constitutes the central theme of this treatise. However, the epistemological problems of the various phases of genetic psychology remain the same, and, like those of gestalt psychology, warrant a restudy in the philosophy of science.

I. PHASES OF GENETIC PSYCHOLOGY

To the degree that the problems of ontogeny and morphology interpenetrate, the history of genetic psychology is theoretically interwoven with the history of gestalt psychology. Nevertheless, in retrospect it appears that gestalt psychology, with its ahistorical perspective, has but a brief history; while genetic psychology, whose perspective is purely historical, itself is given to a protracted and gradual history.

The history of European genetic psychology consists, essentially, of the history of the formation and transformation, influence and counter-influence, of its three main phases. The priority of the German Phase (universities of Germany and Vienna), its perennial intertwinement with the *Gestalttheorie*, its lasting effect upon the French Phase (School of Geneva and the University of Paris), despite the latter's ambivalence toward the *psychologie de la forme*, and despite the resulting emergence of a structural *Teilheitspsychologie* (in contrast to the *Ganzheitspsychologie*), and the subsequent formation of the Northern Phase (School of Utrecht and the Scandinavian universities), in complementarity and corroboration with the German Phase, and its systematic critique of the French Phase, constitute the skeletal framework of this history. There is, too, the partial parallelism, involving theoretical interlacings, between the histories of European and American genetic psychologies, considered as integrated trends.

In America, it will be recalled, genetic psychology was inaugurated by G. S. Hall (1844–1924), the senior student of Wm. James and the originator of the *questionnaire method*, with his research on the "Contents of Children's Minds" (1883), and his resulting formulation of the "recapitulation theory" (the American version of the German "*bio-genetic law*" formulated by K. v. Baer in 1828). However, the work of J. M. Baldwin (1861–1934), also in Johns Hopkins, concerning *Thoughts and Things* (1911), had greater import to European than to American psychologists, as it laid the blueprint for a "*genetic logic*" which influenced the "*épistémologie génétique*" of the French Phase (especially the School of Geneva). Accordingly, it was not until much later that the genetic psychology of genius was studied, by means of the *longitudinal method*, by L. M. Terman (1877–1956) and his collaborators (334) in Stanford. The experimental investigations of the evolution and variation of "intelligence," by F. Goodenough (111) (112), E. Heidbreder (128), and N. Bayley (26) (27), constitute the necessary complement of the aforesaid logitudinal research. And, with respect to the area of genetic psychopathology, the work of L. Kanner (156) of Johns Hopkins is especially noteworthy for its objective functionalism (In contrast, for example, to the orthodox viewpoint of M. Klein the genetic psycho-analyst in England). Parallel to these studies have been the investigations of the problem of ontogeny from the standpoint of physiological psychology as well as comparative psychology. In the former category may be included the work of A. Gesell (102) of Yale University, and of L. Carmichael (58) of the Smithsonian Institution; and in the latter category belong the researches of R. M. Yerkes (374) at the Laboratories for Primate Biology, of H. Klüver (165) in the Animal Behavior Laboratory (Chicago), of H. F. Harlow (123) in the Primate Laboratory (Wisconsin), and of N. R. F. Maier (211) (212). For the rest we must turn to the periodicals. However, while the *Journal of Genetic Psychology* (originally founded as the "Pedagogical Seminary" by G. S. Hall in 1891), being the oldest periodical of the kind in the history of psychology, constitutes the most continuous record of research, it suffers from the gross incompleteness resulting from the predilection of American psychologists to disperse their papers over various periodicals irrespective of the subject-matter.

The theoretical scope of research in European and American genetic psychologies, despite the divergence of their methodology, represent a general parallelism. This scope comprises three main branches of studies: (1) *Psychogenetic studies* which investigate the nature of psychological evolution as a function of psychological factors (e.g. experience). (2) *Biogenetic studies* which investigate the nature of psychological evolution as a function of biological factors, that is, the natural history of the organism (Theoretically, genetic psychology and genetic biology converge here in the concept of *ontogeny*). (3) *Phylogenetic studies* which investigate the nature of psychological evolution as a function of the phyletic scale. This constitutes the domain of comparative genetic psychology, the basic principle of which may be stated as follows: As we descend the phyletic scale, the psychological traits of organisms are more elementary, and therefore genetically prior; and, inversely, psychological evolution is the product of a synthetic process, which begins at the reflexive level of responses and terminates at the reflective level of abstract operations.

Two basic methodological principles are to be discerned at the foundations of both American and European genetic psychologies: (1) That the *phenotype* is to be experimentally studied for the sake of the theoretical determination of the *genotype*. (2) That the *evolutionary method* (involving transverse studies of various age groups) and the *longitudinal method* (involving continuous studies of the successive age levels of a given group) are logically complementary. The main difference between the American and the European studies consists of the degree in which observed behavior is interpreted as the overt index of covert psychological operations, and consequently, the corresponding ratio of experimental data to theoretical concepts in the two contexts respectively. Hence, the relative degree of reliance upon the qualitative or quantitative methods of analysis, the experimental data being constant, is to be referred to the same divergence of perspective in methodology.

1. The German Phase

The history of the German Phase begins with the work of Wilhelm Preyer (1842–1897) at the Universität Jena. First in a historic lecture on "Psychogenesis" (1880), and later in his main work on the *Seele des Kindes* (1882), he formulated the theory of autogenesis, according to which the potential patterns of psychological behavior are essentially innate. Observing that the nascent subject, facing a stimulus for the first time, often displays a predilection towards a given response amongst several alternatives, Preyer concluded that psychological traits are not the *effects* but the *causes* of the behavior of the subject. Rejecting the *tabula rasa* hypothesis of classical empiricism (Locke), Preyer sought to decipher the "mysterious writing" of the mind of the child. Using the *method of observation*, Preyer kept a complete record of the comportment of his own child from birth to the end of the third year. To Preyer belongs the credit for founding genetic psychology in Europe, and for the recognition that, despite the quantification of psychophysics by his intellectual friend G. T. Fechner, the methods of genetic psychology must be primarily qualitative. It may be noted, in passing, that the hypothesis of autogenesis has been revived in contemporary times, manifestly in the form of the inheritance of species-specific traits, in the context of ethological psychology (especially K. Lorenz and N. Tinbergen).

In Germany genetic psychology also derived impetus from biological research. In this respect the work of E. H. Haeckel (1834–1919) at Jena, continuing the line of investigation begun by K. von Baer, is especially noteworthy. Haeckel, in his classic work *Generelle Morphologie* (1866), reformulated the *biogenetic law*: "Ontogeny is an abbreviated recapitulation of phylogeny." The biogenetic law, when applied to the psychic processes, becomes a psychogenetic law. Haeckel, who had studied comparative anatomy and physiology under Johannes Müller in Berlin, did not make this transition; but then, in 1860 when Fechner inaugurated psychophysics, psychology itself was beginning to become independent, as a natural science, from the parent-sciences of physiology and philosophy.

On the eve of World War I, the Institut für Jugendkunde was established in Hamburg (1913); and the following year its director, Wm. Stern (1871–1938), published the *Psychologie der frühen Kindheit.* Stern adopted an eclectic approach to genetic psychology, to be called "personalism," which may be regarded as a prelude to the *Ganzheitspsychologie.* In the effort to explain the evolution of personality, as a psychological system, Stern introduced a set of objective concepts (*biosphere, disposition, introception*), which, in recent years, have been given a systematic form in the "topological theory" of K. Lewin.

However, it was not until after the death of W. Wundt, that the systematic investigation of the phenomena of psychogenesis was undertaken within the framework of the German Phase. Perhaps the most significant result of this period of investigation was the concept of *genetic phase*, which was introduced by O. Kroh (*Subjective Anschauungsbilder bei Jugendlichen* (1922)). The theoretical concept of *phase*, as the correlate of the concept of *periodicity*, has an explanatory function with respect to the empirical concept of *stages*, which is being studied in contemporary genetic psychology. Parallel to this theoretical advancement, the Psychologische Institut in Vienna, under the direction of K. Bühler (*Geistige Entwicklung des Kindes* (1918)), and of Charlotte Bühler (*Seelenleben des Jugendlichen* (1922)), continued to preserve the more traditional biological orientation with respect to the problems of genetic psychology. In any case, as light was shed, whether from the angle of biology or of psychology proper, upon the processes of ontogeny and morphogeny, the pedagogical implications of genetic psychology acquired proportionate distinction.

The school of genetic *Ganzheitspsychologie* (integrative psychology), having been originated in the Universität Leipzig by F. Krueger (189) and his collaborators, was to survive the original group and to become the dominant viewpoint of the German Phase. Under the direction of Krueger was edited the comprehensive series of the *Arbeiten zur Entwicklungspsychologie* (1915–1941) the first volume of which he himself was the author. Since the basic methodological principle of *Ganzheitspsychologie* is the integration of genetic and morphological analyses, it forms a theoretical bridge between the historicism of genetic psychology and the ahistoricism of gestalt psychology. Accordingly, the concept of psychological development is interpreted here in terms of the dichotomy of structural differentiation and integration. The work of H. Werner

(359), and more recently of A. Wellek (356), may be regarded as the representative of the viewpoint of this school, albeit partially, especially in its integrative principles.

With respect to the contemporary research in the German Phase, to which we shall have the occasion of referring in the course of the present work, suffice it here to name the representative figures: H. Thomae (335), at Erlangen and later at Bonn, working on the methodological problems of genetic psychology and the longitudinal study of psychosomatic relationships; W. Metzger (225), at Münster, working on the psychogenetic aspects of cognitive functions; E. Höhn (138), at Tübingen, working on the problem of genetic structuration; R. Bergius (32), at Berlin, investigation the problem of genetic levels; U. Lehr (Bonn) studying the phenomenon of periodicity; E. Duhm (Göttingen) studying the problem of differentiation; M. Koch (München) investigating aspects of comparative genetic psychology; and U. Undeutsch (Köln) being concerned with genetic psychosomatics. For the rest the reader is referred to the general surveys of genetic psychology edited by H. Thomae (336) and by O. W. Haseloff (126) respectively. It is to be deeply regretted that the recent contributions of the universities of the eastern regions of Germany, that used to be great (Königsberg, Jena, Halle, Leipzig), cannot be mentioned here, since an intellectual dark age has descended upon eastern Germany as a result of its recent tragic history.

The *Northern Phase* of genetic psychology is closely related, and partially parallel, to the German Phase. Specially important, for the purposes of this study, is the School of Utrecht where F. J. J. Buytendijk (51) (52) (53) (54), its senior psychologist, has undertaken a systematic analysis of the processes of neurophysiology relevant to the ontogeny and morphology of the phenomena of psychology. The permanent contribution of Buytendijk consists of having derived the logical consequences of an authentic physiology (especially contemporary German physiology in contrast to classical physiology) for the reconstruction of an integrative psychology. In this respect both M. J. Langeveld (196), in his "genetic anthropology," and J. Linschoten (201) (202), in his "phenomenological psychology" (based upon the psychology of Wm. James), corroborate the comprehensive viewpoint of Buytendijk in whose school they belong. We shall return to the contributions of this school, relative to some essential problems, in the course of this study. As for the work of the Scandinavian universities, generally speaking, they are complementary to the School of Utrecht. The problems of genetic psychopathology and pedagogical psychology have been studied by the Danish psychologists, Sofie Rifbjerg and Annemarie Nørvig, respectively. Å. G. Skard (Psychological Institute of the University of Oslo) has been studying the development of Norwegian children as a function of variations in their immediate biosphere and psychosphere. And Helga Eng (Oslo) has made an intensive study of children's drawings, interpreting them as an "expression of their mental development." We may not include here J. Smedslund (discipline of Piaget in Oslo) for, being engaged in a systematic corroboration of the Piagetian studies of the concept of conservation (mass and volume) by controlled experimentation, his work may be regarded as an extension of the School of Geneva. On the other hand, more properly in the spirit of the Northern Phase are the studies of Maria Nagy (235) (236), first in Budapest and later at Radcliffe College, concerning children's conceptions of bodily functions and of death.

2. The French Phase

Priority belongs to the German Phase, recency to the French Phase. The origin of the French Phase may be traced to the work of A. Binet (1857–1911), at the Sorbonne, concerning the development and measurement of intelligence. Although, judged by the standards of German psychology, his *Les idées modernes sur les enfants* (1908) were by no means modern, nevertheless this work propagated the experimental approach in genetic psychology. Later Pierre Janet, also at the Sorbonne, undertook an investigation in genetic psychology the results of which, bearing the descriptive title of *L'intelligence avant le langage* (1936), was not without influence upon the School of Geneva.

The Institut J.-J. Rousseau, for genetic psychology, was founded by Édouard Claparède in the Université de Genève (1912). There Claparède (1873–1939) developed his methodology and began his experimental study of the genesis of hypotheses. In an early paper on the "Psychologie de l'intelligence" in *Scientia* (1917) he reported the commencement of the research at the Institut and promised the future publication of the full report. Then, instead, he wrote and published his *Psychologie de l'enfant et pédagogie expérimentale* (1926) (A new edition of this work was published later by J. Piaget and P. Bovet in 1946). And the promised experimental report ultimately appeared in the form of a monograph, "La genèse de l'hypothèse," in the *Archives de psychologie* (1933–34). Thus Claparède was the original founder of the School of Geneva; and we shall presently review his rudimentary genetic theory.

The psychological research at the Institut Rousseau was at first directed by Claparède and Bovet; and later by Bovet and Piaget. Piaget had come from biology to psychology (having studied zoölogy at Neuchâtel and psychology & philosophy at the Sorbonne) and was to retain the perspective of the naturalist throughout his subsequent work. Accordingly, the influence of Pierre Janet, Henri Bergson, and indirectly of the functional psychology of Wm. James (through Claparède), is discernible in the work of Piaget. Significantly, his doctoral dissertation, concerning the regional alpine malacology, was a typical study in evolutionary zoölogy: It investigated the variation of the given land species as a function of the altitude of the habitat. Later he was to investigate the variation of psychological forms as a function of the age of the subject. The *psychogenetic method*, to be described later, was employed in a long series of experimental studies concerning the ontogeny of logical operations as the indices of the genetic transformation of intelligence. (A constant collaborator in several of these projects has been Bärbel Inhelder). It is true that, in the beginning of his psychological career (1921), Piaget did not know about gestalt psychology; and that, had he known about it, he would have become, given his theoretical propensity, a gestaltist (cf. Piaget's confession to this effect in the *History of Psychology in Autobiography*: IV where he explains the formation of the blueprint for his own system as an attempt to fill this theoretical gap). However, the fact remains that the idea of *Gestalt* had begun to pervade the psychological *Zeitgeist* of Europe during this period; and that, afterwards, when gestalt psychology reached the School of Geneva (through P. Guillaume's *La psychologie de la forme* in 1937), Piaget had already become aware of the "new structuralism" (in contrast to the "old structuralism") and sought to assimilate some of its basic concepts into his own nascent system. After three decades of experimental research, Piaget presented a theoretical summary, *Psychologie de l'intelligence* (1947), which, together with his comprehensive masterwork, *Introduction à l'épistémologie génétique* (1950), constituted the inauguration of the theoretical period of the School. Thereafter the Institut J.-J. Rousseau, under the auspices of the Université de Genève and with a sustaining grant from the Rockefeller Foundation, established its Centre d'Épistémologie Génétique (1955), with its special periodical *Études d'épistémologie génétique* (which accumulated twelve fascicles between 1957 and 1960).

The contemporary research of the French Phase continues in the universities of Geneva and Paris with representation in some other centers (e.g. Psychological Institute in Oslo); and the examination of its varied contributions will be reserved for later. Suffice it here to summarily mention the representative figures and their lines of research. In the Université de Genève, besides J. Piaget and his experimental associate B. Inhelder, there is André Rey in the Laboratoire Psychologique, Albert Morf the critical experimentalist, J.-B. Grize the operational logician, and Gérald Noelting the curator of longitudinal studies, as well as the temporary associates of the Centre. At the Université de Paris, there is Henri Wallon known for his study of the psychogenesis of thought processes, and P. R. Bize who has been engaged in the study of the problems of ontogeny from the standpoint of physiological psychology.

3. *The Psychological Theory of Claparède*

The psychological theory of Claparède (64) (65), which constitutes the first phase of the history of the Geneva School, consists of a methodology and of a generalized conception of intelligence.

The "method of overt thinking," used by Claparède, may be described as follows: The subject is placed in a problematic situation and instructed to think aloud, to express his thoughts as they occur, during the interval extending between the point of the confrontation of the problem and the point of the solution of the problem. The spoken words of the subject are then recorded by the experimenter as exactly as possible. The experimenter intervenes into the situation only at two points: He may intervene when the subject's train of thought temporarily stops, as it were, because of the difficulty of the problem, and offer him a hint; or, again, he may intervene because he would like to introduce a new factor into the problematic situation and observe its effect upon the subject's train of thought. Claparède takes pains to show that the method of overt thinking is different from the method of introspection. He points out two methodological differences. First, the method of introspection appears to generate the "duplication effect" by putting the subject in the position of thinking and observing himself thinking; and the method of overt thinking avoids the duplication effect by asking the subject, instead of reporting this thoughts, simply to think overtly. Second, there is no retrospection involved in the method of overt thinking; while all introspection is, in principle, retrospective. The fact is, as we shall see later in this chapter, both the method of overt thinking and its successor, the psychogenetic method, are really introspective methods.

Let us inspect a case of the application of the method of overt thinking. This is the famous experiment on the genesis of hypotheses by Claparède (65). Although all the subjects used in the experiment were adults, it was in principle a genetic experiment, and Claparède expected parallel experiments to be set up using children. There were thirty subjects, in the main, consisting of students at the University of Geneva. Four classes of tests were used: (i) The ambiguous-figure test in which the subject was asked to form hypotheses concerning the nature and use of an ambiguous figure. (ii) A variety of the test known in American psychology as the Thematic Apperception, in which dramatic pictures were presented and the subject was asked to provide the legend. (iii) The picture-series test in which a number of pictures, representing a story, were presented and the subject was required to construct their sequence. (iv) The completion test which required the subject to complete an incomplete series of pictures, a dialogue, or a sentence. As a result of this experiment Claparède formulated his hypothesis of "groping" which we shall discuss in the context of his theory of intelligence.

Let us turn to Claparède's theory of intelligence. Claparède's definition of intelligence (65: p. 3) is as follows: "Intelligence is in reality the ability to solve new problems by thinking." By "thinking" Claparède means "reasoning," and reasoning consists of "hypothetical reasoning." Consequently, the function of intelligence becomes the "discovery of hypotheses." And intelligence performs this function through a set of three operations:

(1) The "comprehension" of a new problem which constitutes the startingpoint of the functioning of intelligence. This comprehension consists of the understanding of the problematic situation, its constituents, its gap and the fact that something is needed to fill the gap.

(2) The "discovery" or "invention" of the hypothesis necessary for the solution of the problem (Claparède uses the terms "discovery" and "invention" interchangingly (!) with the result that the epistemological dichotomy between realism and nominalism is completely slurred over). In any case, this discovery consists of seeing what actually can fill the gap in the situation. The central question then seems to be: What is the nature of the psychological process by which these hypotheses are discovered? At the end of his long experimental study, described above, Claparède arrived at the conclusion that he had not found the answer. However, no sooner was this formal confession made that he suggested

the idea of "groping" (*tâtonnement*) as an explanatory principle for the genesis of hypotheses.

(3) The "verification" of the hypothesis resulting in the empirical confirmation or infirmation of the same.

It may be observed in favour of this theory that its polar concepts ("comprehension" and "invention") were the forerunners of the concepts of "disequilibrium" and "assimilation" which were to be later employed by genetic psychology. It also bears a striking resemblance to Selz's "cognitive schema" (cf. Humphrey (142)) and to Dewey's well-known analysis of "how-we-think" (72), whatever corroborative value this resemblance may have. Finally, this theory claims to be compatible with the gestaltist theory of thinking. For it considers "insight" (*Einsicht*), as it is understood in gestalt psychology, to be simply the last step in the genetic process of the discovery of a hypothesis.

Critique:

The "hypothesis of groping," as an explanatory principle, added little to the psychology of thought. Indeed, was not this hypothesis already there ever since Thorndike's experiments with chickens (338) in James's basement thirty years before? For "groping" may be considered as the European counterpart of the American "trial-and-error." It is well known that the explanatory value of the hypothesis of trial-and-error has been seriously questioned in contemporary American psychology. And while trial-and-error had been at least capable of yielding quantifiable results, "groping" did not have even this merit.

Claparède's theory of intelligence ended up in "groping" because: *First*, the method of overt thinking was a highly unsystematic method. In the absence of any classificatory framework, the responses of the subject flowed in *en masse*, to be taken at their face value, and the nigh impossible task of separating the relevant responses from the irrelevant was left to the experimenter. The method is a variety of the "method of observation" which, as it will be seen later in this chapter, is considered to be inadequate for genetic psychology. *Second*, the basic concepts of genetic psychology had not yet been formed. Such concepts as "operation," "structure," "equilibrium," and "construction" were yet to come. Consequently, the idea of "groping" was left void of an exact psychological meaning; and, for want of the concept of "construction," Claparède's theory of intelligence fell into the indiscriminate usage of the terms "discovery and "invention" as if they were synonymous.

The descriptive and explanatory scope of the psychological theory of Claparède, with respect to the thought processes, is limited to the hypothetical function exclusively. But it is clear that not all thinking consists of *problem solving*, even if all *practical thinking* may consist of nothing else. There is at least another type of thought process, fundamentally different from problem solving, and it is related to *concept formation*. Historically, conceptual thought has been regarded as the main form of thought (cf. James (146)). And American psychology has been engaged in the experimental and theoretical investigation of concept formation as well as problem solving (cf. Helson (130)). It is true that the two processes are often interwoven: In a problem solving experiment the task may consist of concept formation, and the subject will then be able to obtain the solution of the problem only through the attainment of the concept; or, again, a concept formation experiment may present to the subject a problem to be solved, and through the solution of the problem he may attain the concept. But there is an epistemological difference between the processes of problem solving and concept formation: The thinking involved in the former is essentially *hypothetical*, and the thinking in the latter is essentially *abstractive*. The types of thought processes, including these, will be investigated in Chapter 6. Suffice it to remark here that Claparède's theory of intelligence has no explanatory space for the phenomena of the "attainment of concepts" to use Heidbreder's expression. It may be noted further that the theoretical concepts employed by Claparède have received a stark criticism from I. P. Pavlov (249) from the standpoint of reflexology; but we shall examine the relevance of reflexology to the phenomena of genetic psychology and gestalt psychology within a methodological context later.

II. PSYCHOGENETIC METHOD

The French Phase of genetic psychology consists essentially of a theory of thought processes (intelligence) and of perception together with the relationship of the latter to the former. The theoretical objective of this psychology, stated in its most general form, is twofold: First, the qualitative description of cognitive phenomena as a function of time; second, the explanation of cognitive phenomena with reference to a set of psychological operations.

The methodology of genetic psychology, relative to the attainment of its complex theoretical objective, involves both empirical and logical methods. There is, firstly, the "psychogenetic method" (*méthode psychogénétique*) which performs the experimental and descriptive part of the research; and there is, secondly, the "operational logic" (*logique opératoire*) which performs the analytical and systematic task within a theoretical framework.

The psychogenetic method has evolved from the earlier methods of genetic psychology. Contemporary genetic psychology avoids the use of either the "method of observation" (Preyer) or the "questionnaire method" (Hall), but attempts to obtain a critical synthesis of these classical methods together with the "method of overt thinking" (Claparède) and the "method of clinical examination" (Janet). Of course, the "psychogenetic method" is an old method essentially, since the *Ausfragemethode* (to be distinguished from the written *Aussagemethode*) was practiced in the Würzburg School (by Bühler under Külpe around 1908), and later by Katz (at Rostock around 1920) in the form of "conversations" (*Gespräche*) with children. In the following we shall briefly review the critique of the classical methods from the standpoint of contemporary genetic psychology:

(1) The *questionnaire method.* This method, which is very useful in clinical psychology, unfortunately lacks the same utility in genetic psychology. For, by having the questions fixed in advance in a certain way, it distorts the child's psychological propensity by rechanneling it. To take an example: In attempting to find out the child's conception of the movement of the sun the questionnaire might ask: "*What* makes the sun move?" Now, regardless of the veracity of the answer given by the child, all his answers to this question would be with reference to an external agent causing the sun to move. But if—as it is quite likely to be the case—the child's conception of the movement of the sun be animistic, then neither the child would have ever asked himself the above question in the above form, nor would his answers to the question have revealed his true thought on the subject. His answer might be: "The wind makes it move," "The sky shoves it along," etc. But he will really believe none of these answers, for the sun might very well move, according to the child's thought, on its own like a living organism. Rephrasing the question—e.g. "*How* does the sun move?", etc.—will merely result in a distortion in another direction. And a combination of these different questions, differently phrased, will elicit a set of mutually inconsistent answers instead of a true answer. And this distortion, arising as it does from the suggestive nature of the question, could not be avoided if the questionnaire method were to be used.

(2) The *method of observation.* This method is particularly valuable in the field of the psychology of behavior. In genetic psychology its validity is limited to the study of the autonomic behavior of the child. It turns out to be an inadequate method when applied to the study of the cognitive phenomena which constitute the main objective of genetic psychology. The psychologist, using the method of pure observation, is obliged to take all the responses of the subject at their face-value; for it would be impossible for him to separate the relevant from the irrelevant responses. To take an example: Relying solely on the method of observation, the psychologist will have no way of distinguishing between the responses caused by *belief* or by *play.* Thus when the child at play turns with a serious demeanor to the wooden toy and calls it by a personal name, is he merely playing or does he really believe in the animation of the wooden object? In such cases the method of pure observation is not sufficient to determine the answer. The "method of overt thinking" (Claparède) too, it may be recalled, was actually a variety of the method of observation and suffered from similar inadequacies.

The *psychogenetic method* appears to combine the merits of the methods of observation and questionnaire and avoid their pitfalls (cf. Piaget (256)). The principles of this method are as follows: (i) Against a setting as ordinary as possible, a *dialogue* is held between the subject and the experimenter. Distractive factors are eliminated from the immediate environment, and perhaps a mild degree of incentive introduced (e.g. the child may be given a reward for his cooperation).
(ii) The psychologist's conversation must be *neutral,* that is, it must be bereft of all suggestion as far as possible. Examples of suggestiveness are: Formulating the question in a preconceived way, causing the child's answer to be rechanneled from his psychological propensity; phrasing the question in a language that is different from the child's usage of language, causing far-reaching interpretations on the part of the child which are not intended by the psychologist; persistence in conversation along a given line of questioning, causing the child to persist in turn along a given line of answers.
(iii) The psychogenetic method is an *experimental* method. The psychologist begins with a specific problem, constructs a hypothesis, and controls the conditions for the verification (confirmation-infirmation) of the hypothesis. The psychologist must unite in his approach two seemingly incompatible qualities: To avoid on the one hand the distortion of the data due to preconceived ideas and suggestiveness; and, on the other, to avoid their incoherence due to the absence of a guiding hypothesis.

(iv) The genetic psychologist will have to *reconstruct* the structure of the responce pattern, which is frequently ingressed in vagueness and irrelevance, by screening out the irrelevant data in accordance with a set of criteria. Admittedly this reconstruction of the data is both a difficult and a dangerous task—it requires no little degree of introspection and *Fingerspitzegefühl*—but it is equally indispensable if the pitfall of simplification is to be avoided. The undue simplification would consist of assigning to every response either its maximum or its minimum value—accepting everything that the child says at its face-value or discarding everything as nonsense.

(v) Relative to these problems Piaget (256) has constructed a methodological schema into which all the cognitive responses of the child may be classified. This schema consists of five categories: (a) The category of *random responses*—which includes responses which have the probability coefficient of 0.50. (b) The category of *fictional responses*—which includes the answers invented by the child. (c) The category of responses based upon *suggested-conviction*—which includes the answers given to suggestive questions. (d) The category of responses based upon *liberated-conviction*—which includes answers arising out of reflection in response to a new question. (e) The category of responses based upon *spontaneous-conviction*—which includes answers which have already been formulated in the subject's thought and require no further reflection.

(vi) These five categories of responses are not all of *equal* value to the psychologist. Two types, the random answer and the suggested-conviction, are void of any value: The random answer, because it involves neither a construction nor an invention on the part of the child but merely indicates the absence of comprehension; and the suggested-conviction, because it suggests nothing to the psychologist but the suggestibility of the subject by the psychologist's unintentional suggestions. None of these two types of responses then throw any light upon the intellectual pattern of the subject. The categories of liberated-conviction and spontaneous-conviction, on the other hand, do reflect the subject's psychological structure. As for the category of fictional responses, it presents a subtle case. On the one hand it has a non-veridical nature; and on the other hand the nature of the fiction itself is a function of, among other things, the subject's intellectual make-up. For, it must be admitted, that even a fiction is not invented out of nothing—especially not a "psychological nothing." The material and the style of the subject's fictionalism then, in an oblique fashion, point out toward his psychological propensity.

(vii) The general *criteria* for distinguishing these categories of responses are as follows. There are three criteria by which the suggested-conviction can be discerned: (a) A counter-suggestion, posed after a short interval of time, destroys the suggested-conviction. (b) The suggested-conviction is not rooted firmly in the psychological ground around it: No bonds of inference or deduction tie it to the subject's other veridical convictions; and some probing by the psychologist around the response would reveal this fact. (c) The suggested-conviction dissipates when the psychologist presents the question in various forms such that they cancel off their reciprocal suggestiveness. These criteria apply to the category of the random responses equally well, for the random response is even more groundless and unstable than the suggested-conviction. For the suggested-conviction is at least based upon the suggestiveness of the question, but the random response indicates the subject's lack of comprehension. As for the fictional responses, they again present a subtle case. It is not always easy to discern a fictional answer from the liberated and spontaneous convictions, because fictions may be based upon other fictions and thus have the appearance of a consistent system. The following criterion then may be laid down for the diagnosis of the fictional response: Taking a large number of subjects of different age-levels, if the suspected answer appears throughout a given age-level, and its trace tapers off in both age directions, then it is not likely to be a fiction. For fictions have, in general, no evolution and are singulary peculiar to a given subject. The spontaneous and liberated convictions both pass the criteria laid down for the non-veridical categories: Both resist suggestion; both are deeply rooted in the psychological pattern of the subject; both have a wide generality relative to the same age-level; both alter gradually in time rather than appear or disappear suddenly. For these reasons these two categories of responses may be assigned the highest psychological value.

(viii) The genetic psychologist *reconstructs* the raw data of the experiment: He first classifies the given response into one of the five categories described above, and then he assigns to the response the value corresponding to its category. Thus, for the genetic psychologist, not all the responses have equal value. He must separate the truly representative responses from the trivial reactions, and thus escape the spell of "systematic error," which always haunts the statistical experimentalist.

(ix) The subject's responses are considered to be *symptoms* rather than realities in the final analysis. Hence, they are to be treated as an integrated index which, when adequately interpreted, will reflect the psychological operations that lie behind it. And it is the study of the evolution of psychological operations and configurations that constitutes the main objective of genetic psychology.

It is because of these methodological principles, which reject the naive acceptance of verbal behavior as the ultimate data of the experiment, that genetic psychology, seeking the explanation of behavior in the covert psychological operations, in a profound sense reaches deeper than behaviorism. There are two main types of experiment in which the *psychogenetic method* is employed:

(1) *Evolutionary studies* which consist of a series of cross-sectional experiments on different groups at various age-levels. By far the greatest portion of all experiments in European genetic psychology are of this type, including all the main studies of the School of Geneva (with one important exception to be discussed later).

(2) *Longitudinal studies* in which a single group of subjects is used and the variation of responses is studied as a function of the progression of age. In the context of the German Phase, the work of Thomae (335), and in the context of the School of Geneva, the work of Noelting (239), are significant in this respect. This type of study, which is of relatively recent origin (discounting its progenitor in the "observations" of Preyer) in Europe, is represented by two typical studies: A four-year longitudinal study testing the "hypothesis of stages" by Noelting and Inhelder (240) at the University of Geneva; and a longitudinal study of the psychophysical relationships by H. Thomae (335) at the University of Erlangen. American genetic psychology, in contrast, appears to have already established its scientific history of longitudinal studies. The representative works in this area are well-known: There is the series of "genetic studies of genius" by L. M. Terman and Coworkers (334), there is the twelve-year longitudinal study of intelligence by F. Goodenough (111), and there is the longitudinal study of the variations of intelligence by N. Bayley (26). Implicit in these studies is the fact that very different methods are employed: European studies employ the psychogenetic method (or, in some cases, the method of empirical observation), and the American studies employ consistently the functional experimental method.

Two aspects of the psychogenetic method, which are of considerable methodological importance, may now be examined. The first aspect involves the relationship of this method to introspection; and the second, the qualitative nature of this method. Our examination of these aspects here will be relatively specific in nature, and the general critique will be reserved for Chapter 8.

In the final analysis, it appears that the psychogenetic method is an introspective method. This summary statement requires explication, since there are varieties of introspection. The variations of introspection can be diagnosed from two standpoints: the *content* or the *technique* of introspection. In an essay, which itself employs no little degree of historical introspection, Boring (41) has discerned the varieties of introspection, suggesting that introspection, instead of having become extinct, has rather undergone a metamorphosis in modern psychology. This interpretation appears to be true with regard to the content as well as the technique of introspection, with regard to *what* is introspected as well as to *how* it is introspected. Thus, for example, the elementistic content found in the introspective data of Wundt and Titchener stands in sharp contrast to the configurational contents revealed in genetic and gestalt psychologies. Yet, it is under the same light of introspection that both contents are brought before conciousness; even though, in the former case, the introspective operation performed, is *direct*, and in the latter case, it is *indirect*. For, in "classical introspection," where the experimenter and the subject of experimentation coincided in auto-introspection, the psychologist sought to discern his own "contents of consciousness," while in "modern introspection," where the experimenter and the subject are separated by a constant methodological distance, the psychologist seeks to discern, by observing the overt behavior of the other, the underlying contents and operations of consciousness. The familiar and indispensable categories of *inferred entities* and *intervening variables*, in contemporary psychology, represent the theoretic product of this kind of heterospective introspection. And, considered in this light, empirical psychology is, as it has been in its classical period, essentially an experimental-introspective science. However, while American genetic psychology engages in introspection to a minimum degree, the European genetic psychology, in all its phases, engages in it to a maximum degree. It is this profound engagement in introspection which is meant when we say that European genetic psychology is an introspective psychology, and that the psychogenetic method is an introspective method. For this method, as we have seen, attempts to discern the *latent content* (psychological operations) which lies behind the *manifest content* (behavior). For the appreciation of the qualitative nature of the psychogenetic method, in contrast to the quantitative methods, it is necessary to stress this methodological point.

That the psychogenetic method is essentially a qualitative method is evident. By refusing to assign an equal value to all the responses of the subject, this method departs from the ordinary statistical approach. And although it uses large groups of subjects, the results are hardly quantified beyond the recording of the percentages in comparative tables. If the statistical methods, as they are used (perhaps overused) in American psychology, are foreign to the European genetic psychology, it is because the latter does not rely on them as the best approach to the investigation of genetic phenomena. For, it is not the functional correlations of observable variables that this school of psychology is after, but rather the psychological structures that lie behind the observable variables. Consequently, genetic psychology is not satisfied by a simple qualitative description of the experimental phenomena; it also seeks the theoretical explanation for these phenomena. How can this methodological dilemma be resolved? The methodological warfare between gestalt psychology and operant behaviorism, which haunted the functional psychology in America, produced reverberations in Europe. European genetic psychology, which did not remain unaffected by this theoretical strife, derived a lesson from it: Namely, that the method of simple qualitative description is not enough; but that the methodological gap could not be filled either by physiology or by statistics (employed by reflexology and by behaviorism respectively); therefore genetic psychology turned toward the science of logic instead. The objective was to subject the "raw data" of the psychological laboratory to a twofold refining process before they are to be accepted as the final results: Firstly, the experimental reconstruction of the data by the psychogenetic method; and secondly, the logical analysis and synthesis of the experimental data within a theoretical framework. It is in this way that the two methods of genetic psychology, "psychogenetic method" and "operational logic," may be considered to be complementary methods. The epistemological significance of this methodological complementarity is that logic and psychology, both being concerned with the nature of thought processes in different ways, and having been separated in the early period of modern science, were now being brought together again in the context of genetic psychology.

CHAPTER 2

LOGIC AND PSYCHOLOGY

The history of the interrelationship between logic and the biological sciences (including psychology), if it were to be traced from Aristotle to Wundt, and from Wundt to Piaget, would manifest a remarkable conceptual transformation. This transformation, however, appertains more to the contents of logic itself rather than to its basic relationship to the natural sciences. The essential objective, throughout, has remained the same: If the physical sciences, given their quantitative nature, have been able to engage the services of mathematical analysis, then the biological sciences, given their qualitative framework, have more appropriately sought to engage the methods of logical analysis. For logic necessarily possesses two essential traits which render it a proper instrument for cognitive psychology as well as comparative biology. Firstly, it consists of a system of qualitative schemata, in contrast to the quantitative atomism of the statistical methods; and secondly, it is susceptible of a high degree of precision, relative to the inexactness of the method of simple description. Thus logic, combining the merits of both the morphological and the mathematical analyses, permits psychology to pursue its objectives without methodological compromise: Namely, the description and explanation of psychological phenomena (cognitive, emotive, and adaptive), with a reasonable degree of precision, with reference to a set of psychological structures and operations. In this chapter, we shall first examine the theoretical relationship between logic and psychology, and subsequently describe the special system of logical analysis employed in genetic psychology (especially the School of Geneva).

I. RELATIONSHIP BETWEEN LOGIC AND PSYCHOLOGY

The sciences of logic and psychology both are concerned, albeit in different ways, with the nature of the "higher mental processes"; both study, within their respective frameworks, the operations of thought and the laws governing them. What is then the theoretical borderline between these two sciences; and what kind of relationship holds between them? It appears to be imperative to investigate the solution to these propaedeutic problems, before examining the possible use of the methods of logic in the context of psychological science.

Logic is the theoretical science of the abstract forms of reasoning, their validity and invalidity, and their general laws. The three essential aspects of the science of logic may be summarily described as follows:
(1) The objective of logic is to study the morphology of the operations of thought and the necessary conditions for the validity of arguments. The perennial problem of logic, given a set of propositions, is: What do these follow from, and, what follows from these? And the solution to this general problem is always achieved in the light of the "logical models" for valid reasoning and the "universal laws" of logical thinking.
(2) The contents of logic consist of an axiomatic system constructed by the method of rigorous deduction. The essential traits of this system are: (a) The logical system is prefixed with a metaphysical metasystem, that is, the concepts and principles necessary for a logical inference are included in the system. (b) The semantic formulae for concepts and the syntactic formulae for propositions (formation formulae and transformation formulae) are explicitly described in the form of axioms. (c) The number of primitive elements in the system (constants, quantifiers, operators) is retained at a minimum, since it cannot be reduced to nothing, and the derivative elements are explicitly defined in the system.
(3) The propositions of logic are analytic in nature, in contrast to the empirical propositions of the natural sciences which are synthetic. A proposition may be described as *analytic* when: (a) Its predicate-concept is logically contained in its subject-concept (Kant), and (b) Its truth rests upon logical grounds in contrast to empirical grounds (Frege). It may be noted that analyticity does not mean tautology; for the proposition is, semantically, something more than the sum of its parts. Consequently, in the judgment of this author, the recent logical controversy over this time-honored philosophical dichotomy has been a futile attempt to blur a clear distinction. As for the critique of the same dichotomy from the standpoint of genetic psychology, it will be examined later in its proper context (cf. Chapter 4: V).

In contrast to logic, *psychology* studies the natural evolution of the operations of thought, their ontogeny and transformation, and their state of equilibrium. The theoretical objective of psychology is to investigate the properties of these operations in different contexts and at different levels of their evolution. Psychology has discovered that the emergence of logical operations is made possible *after* the psychological operations have attained the high degree of equilibrium which is characterized by "reversibility"; thus the analytic conceptions of logic appear to correspond to the equilibrate configurations of psychology. As for the problems of psychology, as a natural science, these will be investigated later and we shall say nothing about them here (cf. Chapter 10: I).

The theoretical *borderline* between logic and psychology was first traced by the great logician G. Frege (97). He observed that the forms and operations of thought, which logic seeks to axiomatize, psychology seeks to describe from the empirical standpoint. This borderline has been subsequently accepted by contemporary psychology. Accordingly, as Piaget (266: p. 27) has described it: "Logic is the axiomatics of reason, the psychology of intelligence being the corresponding experimental science." The borderline between logic and psychology also constitutes a theoretical bond between them: For the two sciences, autonomous in their functions, are complementary in their objectives. Their respective methodologies are clearly different and must be kept separate; but this sharpening of the borderline between the two sciences does not mean that they are irrelevant to each other. Psychology does in fact utilize logical analysis in the description of its phenomena and in the formalization of its theories. And logic, too, can profit from the bearing of the psychological perspective upon logical theories. The professional logician often resorts to the pet argument to the effect that: Since the perspective of psychology remains wholly irrelevant to the internal consistency of the logical system, then psychology has nothing to offer to logic. This argument is a perfect example of the logical enthymeme: Its stated premise is true, however its conclusion does not follow from it alone, the hidden premise being that the logician is not concerned with any other aspect of logic except its internal consistency. However, this is not the case. Logicians study, not merely the mechanisms of the logical system, but also its epistemological and ontological aspects. Logicians operate, to use the logical terminology, in the "systemic" as well as in the "metasystemic" contexts. They have, not merely logical systems, but also logical schools. It is the body of knowledge accumulated as *logical theory*, in contrast to *logical technique*, to which psychology as a natural science is relevant.

The twofold relationship between logic and psychology is to be described as follows: Firstly, the application of the methods of logic in the analysis of the experimental data of psychology and in the formalization of psychological theories. Such an application is illustrated in the works of Piaget (273), Inhelder & Piaget (145), and Hull (141). Secondly, the application of the perspective of psychology as a natural science in the theoretical interpretation of the contents of logic. The works of Wundt (372), Wertheimer (364), Piaget (264) (270), and Kantor (159) provide illustrations of such an application from different standpoints.

Throughout the preceding discussion the term "logic" has been used as referring to an objective body of knowledge which constitutes an exact science. However, it may be observed that the contents of the science of logic have been subjected to controversial interpretations in contemporary philosophy. This controversy concerns the ontological and epistemological status of the concepts and laws of logic, and not the methodology of logic, a fact which attests to the objectivity of logic as a science. It is outside the scope of the present treatise to enter into the ramifications of this controversy. Instead, we shall endeavour to present a comparative and critical overview of the conflicting viewpoints, weighing them against the naturalist scale of psychological science.

The first viewpoint is that of *logical realism* which is maintained in its classic form by Frege (97) and by Whitehead (365). Historically, the origins of this viewpoint may be traced to the "theory of ideas" in the metaphysics of Plato. Its main thesis is that the elements of logic are metaphysical entities existing in logical space. The set of corollaries following from this thesis are: (a) That logic studies these abstract entities and the interrelationships between them, but these exist independently of the logician's knowledge of them. (b) That there can be only one true science of logic corresponding to the ideal realm of reality respectively. (c) That the science of mathematics is deducible from the science of logic by means of logical concepts and principles. It may be observed, without going into further detail, that the great contribution of logical realism consists of: Firstly, the demonstration that logic and mathematics, given their pervasive applications in the natural sciences, are higher level sciences, and are to be treated by no means as arbitrary symbolic games. Secondly, the demonstration that the reduction of arithmetic to logic results in providing the concepts of mathematic- with a logical meaning. Psychology cannot question the logical consistency of this viewpoint, it will not question its ontological commitment, but it will investigate its epistemological presuppositions. For, while this viewpoint maintains that abstract entities have an *a priori* status, from the psychological standpoint it appears that, even if abstract entities were ontologically *a priori*, epistemologically their attainment by the subject is an *a posteriori* process.

The second viewpoint is that of *linguistic formalism* which is maintained by the positivist school generally (notably Wittgenstein (369) and Carnap (58)). The main tenet of this viewpoint is that logic consists of a "well-formed language," that the symbolism used in logic constitutes the sole content of logic, and that this content has no other reference (coincidence of sign and significate). The corollary that follows from this tenet is that logic is a matter of convention and not of discovery; and that, consequently, it is possible to construct more than one "sciences of logic" since there is no one true science of logic. Evidently, behind the radical conclusion of this viewpoint, there lies a critical ambiguity. For it is possible to interpret the term "well-formed language" in two different ways.

We shall first inspect the psychological interpretation, according to which the term means a complete system of language by means of which the subject is able to express his perceptions, feelings, and thoughts. And if, in this sense, logic were essentially nothing but a well-formed language, then a well-formed language would be the sufficient condition for the formation of a complete system of logic. But the experimental facts of genetic psychology demonstrate that this is not the case; and on the basis of these facts Piaget (270) criticizes the theory of linguistic formalism. Of the numerous experimental studies, which provide empirical support to the psychological critique, a typical case may be cited here. This case illustrates that, at a certain age, while the child has formed the language well, nearly all the important concepts and principles of logic are absent from his thought processes. The subject (age 5–8 years) is given a wooden box containing twenty wooden cubes (class B). Most of the cubes are blue (class A_1), and some are white (class A_2), so that $A_1 + A_2 = B$. The subject realizes that all cubes are made of wood, but that they are not all blue in color; he also realizes that there are more blue cubes than white cubes. Yet when he is asked by the psychologist: "Are there more blue cubes (A_1) or wooden cubes (B) in the box?" He does *not* answer that obviously there are more worden cubes than blue cubes, that is, $B > A_1$. His attention alternates between the main class (B) and the subclasses (A_1 and A_2), separately, without looking at these as classes in *relation* to each other. His typical answer is: "There are more blue cubes (A_1) than wooden cubes (B), because there are only very few white cubes (A_2)." That is, $A_1 > B$ because $A_1 > A_2$! Now from the standpoint of linguistic formalism there is no explanation for the failure of the child to give the correct answer, since he demonstrably possesses all the linguistic ingredients necessary for such an inference and its expression. What the child does not yet possess is the psychological structure corresponding to the logical form of the concept of class inclusion ($A_1 + A_2 = B$). And it is this basic fact, not any linguistic inadequancy, which prevents his making a logical judgment. It may be concluded that, from the psychological point of view, logic is something more than a "well-formed language."

The logical interpretation of the term "well-formed language" arrives at a result parallel to that of the psychological interpretation, namely, that logic is transcendent to language. According to Carnap, the term "well-formed language" is to be interpreted to mean, not any particular system of natural or artificial language, but rather the very "skeleton of language"; and apparently one "skeleton" is sufficient to serve as the model for many languages. The question then arises concerning the nature of this "skeleton of language": If it is not a particular language, then what sense is there in calling it a "well-formed *language*"? For, since this "skeleton" is logically transcendent to all particular languages, it would be incorrect to call it a language. Much controversy would be avoided if formalist logicians, in their inveterate fear of the abstract, did not seek to apply a concrete term to an abstract conception. Logic consists of a system of "logical structures," and since there is such a thing as the logical structure *of* language, logic is trancendent to the various languages. It is noteworthy that, in a world of plurality of languages, there remains perennially one science of logic (despite the aspirations of positivism to the contrary). Frege (97) has justly remarked to the effect that "to take formalism seriously is to overthrow it!" Perhaps the gravest defect of linguistic formalism lies in its theory of objective reference. For this viewpoint appears to neglect the logical truth that the same concept (idea) can be expressed by means of different symbols: It overlooks the fact that even in the simplest equations of logic (e.g. class inclusion: $A + B = C$), it is not that the terms of the equation are symbolically identical, but rather that their identity lies in the logical structure of the concept which constitutes their objective reference. Linguistic formalism, however, does not recognize the existence of such a reference. Evidently, fundamental logical controversies ultimately lead to metaphysical controversies. Later, in the last chapters of this work, we shall transfer the burden of blaming positivism from its logical doctrine to its epistemological and metaphysical doctrines. Suffice it to note here that, while rejecting the idea of reference in the context of its "language game" (systemic context), it nevertheless employs it in the construction of its "theory of the game" (metasystemic context); thus, inconsistently, the symbols in the former context are made the reference of the symbols in the latter context. Besides whatever metaphysical biases which the positivist philosophy might entertain, there appear to be certain psychological presuppositions which are responsible for their difficulties at least partially. Outstanding among these presuppositions is one concerning the psychological relation between thought and language: Since language is considered to be somehow prior to the thought processes, logic is defined in terms of language. A critique of this assumption will be undertaken later in the general context of our investigation of the relationship between thought and language from the psychological standpoint (cf. Chapter 6: I).

There is a third interpretation concerning the nature of logic, namely the *phenomenological theory*, which goes beyond both logical realism and linguistic formalism. It may be noted, however, that the phenomenological theory is far closer to logical realism than to linguistic formalism: In fact the only essential point of divergence between the former viewpoints is the problem of whether logical forms are *a priori* or *a posteriori*. The framework of this interpretation has been developed in German phenomenology (notably Husserl (143)), in gestalt psychology (notably Wertheimer (364) and Köhler (170) (173)), and in genetic psychology (notably Piaget (266) (270)). What Wertheimer has described as "gestalt logic," and Piaget as "operational logic," is essentially a "structural logic" consisting of a system of abstract gestalten and abstract operations. Indeed logicians of the school of realism have also occasionally thought of logical ideas in terms of configurations. And the very fact, that the forms of classical logic have been given figurative representation by means of the Venn diagrams, constitutes an historical testimony. In a sense, the phenomenological theory is supplementary to the theory of logical realism, for the former renders explicit what is already implicit in the latter. In any case, as Kantor (159, I: p. xiii) has sought to demonstrate in his comprehensive work concerning logic and psychology, "no matter how logic is defined it entails a psychological dimension which must be taken into account." The main thesis of the phenomenological theory then may be stated: The science of logic consists of a system of abstract structures, and since, from the psychological standpoint, logic is a reflection of the constant configurations of thought, logical structures correspond to isomorphic psychological structures. Thus, in the last analysis, the contents of logic turn out to be psychological contents; and what is ontologically *a priori* becomes epistemologically *a posteriori*. The concepts of "configuration" and "abstraction," accordingly, constitute the essential elements of the phenomenological theory; and the logical examination of these concepts will be undertaken later (cf. Chapter 7). Whether professional logicians receive the phenomenological interpretation with favor or with misgivings, it would depend upon their psychological assumptions concerning the nature of thought. Logicians are generally inclined to consider the thought process to be the copy of the forms of logic. Psychologists made that mistake once, in the laboratory of the Würzburg School, and learnt a thoughtful lesson from it. Accordingly, Piaget (266: p. 27) observes: "Logic is the mirror-image of thought and not *vice versa*." And, with respect to the nature of thought processes, the phenomenological point of view coincides with the psychological point of view.

A set of corollaries follow from the phenomenological theory of logic: (1) That there is in reality one true system of natural logic. Phenomenology, like logical realism, rejects conventionalism. The conventionalist argument, for the possibility of multiple "logics," is based upon the analogy between logic and geometry which is not quite valid: For the relationship between logic and the mathematical sciences (including geometry) is logically asymmetrical, since the latter contain the concepts of the former but the converse is not the case. Hence, the mathematical sciences, to the extent that they have a logical structure, are not independent from the science of logic. (2) That the analyticity of logical propositions represents structural intensionality and not verbal tautology. "Analyticity" means that the same logical idea is represented by different intensional combinations; and "tautology" means that the same intensional combination is expressed by different symbols (words). The pervasive and powerful applications of logical and mathematical analyses, especially to the natural sciences, are possible precisely because those are not mere tautologies. (3) That, since logic is essentially an intensional science, the concept of "truth" must be redefined in configurational terms. Relative to this Wertheimer (132) and Köhler (170) have investigated the relationship between "factual correctness" and "logical truth." The resulting logical dichotomy constitutes a significant contribution to the science of logic: "Correctness" is predicated of a single proposition, and "truth" of a configuration of propositions. For a proposition, taken by itself, may be correct; but its degree of truth is determined by the general context (totality of propositions about the same object). There appears to be a parallelism between this dichotomy and the classical dichotomy between "analyticity" and "validity." The conception of logic, as the morphology of abstract thought, remains "open at the top," so to speak. For this viewpoint is, not merely consistent with the famous "open theorem" of Gödel in higher mathematics, but also anticipates a psychological interpretation of this significant phenomenon of systematic thought with reference to the levels of abstraction and integration.

The phenomenological viewpoint, then, seeks to critically assimilate the hypotheses of logical realism together with the empirical results of psychology. Two sciences, especially when there is a theoretical affinity between them, may shed light upon each other. The separation of logic and psychology, since the early period of modern science, permitted the healthy growth of each, but now the gulf is to be bridged if these sciences are to learn from their great differences of perspective.

II. OPERATIONAL LOGIC

European genetic psychology has reconstructed the system of logic from a structural point of view. The "operational logic" (*logique opératoire*), as it is properly called, consists of a system of "operations" which correspond to equilibrate psychological structures. It is maintained, that the structures of thought, through their psychological equilibrium, attain the constancy and reversibility which characterize the analytic operations of logic. The apologia of genetic psychology is stated by Piaget (273: pp. 95–96): "It is not then playing upon words to explain the genesis of elementary logical structures by the process of equilibration: It is the only valid way of avoiding simultaneously the a-priorism of innate forms, the empiricism of acquired forms, and the conventionalism of forms with purely verbal origins." It remains to be seen to what extent "operational logic" succeeds in fulfilling the requirements described in this apologia. The essential elements and principles of operational logic will be outlined in the following. This outline is based upon the logical works of Piaget (264) (268) (270), with comparative references to the works of Frege (97) and Wittgenstein (369). Should a reader, especially interested in pure logic, wish for more detail than will be presented here, he is referred to the logical writings of

Piaget himself. However, it is expected that this outline will provide a logical frame of reference sufficient for the description and analysis of the phenomena of genetic psychology to be presented in this book.

1. Basic Concepts:

In general terms *operational logic* may be defined as the systematic theory of the abstract operations of thought at their highest level of equilibrium.

An "operation" (*opération*) is a psychological cycle of events which has been interiorized into a constant structure in thought. "An operation is a regulation which is completely reversible in a system which is completely equilibrate" (Piaget (273: p. 37)).

Interiorization is a psychological process which may be described as "constructive abstraction," in contrast to the "subtractive abstraction" of classical empiricism, resulting in the attainment of general ideas. Two sets of factors, the perceptual properties of the object *and* the conceptual framework of the subject, constitute the sufficient condition for the process of constructive abstraction. The epistemological problem of abstraction will be discussed later (cf. Chapter 7).

An operation is *reversible* when its logical inverse leaves its conceptual identity unchanged.

There are two kinds of operations: (a) *Concrete operations* which require perceptual configurations as the contents of their logical transformations. (b) *Abstract operations* which, being completely independent of perceptual processes, require the purely cognitive contents for their logical transformations.

A *psychological structure* consists of a set of elements integrated into a relational configuration and manifesting a synthetic quality which is logically transcendent to the former elements. There are two general kinds of psychological structures: perceptual structures *and* conceptual structures. The epistemological problem of configuration will be discussed later (cf. Chapter 7).

A structure is completely *equilibrate* when: Firstly, it has fulfilled the logical conditions of equilibrium to be described in the following pages; and secondly, it has attained the psychological properties of equilibrium to be described later (cf. Chapter 5: II).

Concepts are operations: This formula seems to hold in "psychological operationism" (Piaget) as well as in "physical operationism" (Bridgman). However, there is a fundamental difference between these two viewpoints: For the concept of "operation" acquires diametrically opposed meanings in the two contexts. For "physical operationism" an operation is a unit of behavior, usually in the form of physical measurement, and the aggregate of such units constitutes a "concept"; hence the concept is defined, operationally, as a set of operations corresponding to it. For "psychological operationism," in contrast, an operation is a psychological configuration, with a high degree of logical equilibrium, attained by the process of constructive abstraction.

A *concept* is a logical intension, which entails perceptual extensions, and which corresponds to an abstract psychological structure. Following Frege (97), we may say that the logical structure of the concept consists of a set of "marks" with a given interrelationship. These "marks" may be described as simple structural elements which may consist of simpler concepts. The "properties" of a concept, then, are the "marks" of a higher level concept under which the given concept falls. And when an object falls under a concept then the properties of the object correspond to the marks of the concept under which it falls: E.g. the proposition that "The white rat (object) is (relation) a gregarious laboratory animal (concept)." In general, the properties of the object correspond to the description of the marks of the concept implicit in its definition. However, to avoid the paradoxes of predication, it is necessary to assign different logical levels to objects and concepts respectively: (0) for objects, (I) for first-level concepts under which objects fall, (II) for second-level concepts under which first-level concepts fall, (III) etc. Thus operational logic accepts the famous "theory of types" (Frege and Russell) but from a structural perspective.

A *class* may be defined as the extension of a concept such that any object which falls under that concept is a member of the class. An object may be said to be a *member* of a class when the logical structure of the concept of that class is reflected by the qualitative structure of the object.

A *class* is *not* identical with the *aggregate* of its individual members. There are two reasons for this: First, for the attainment of the concept of a class it is not necessary to have first known *all* the individual members of that class. Second, the thesis that classes are the aggregates of their members generates a logical paradox: A class cannot consistently be the aggregate of its sub-classes *and* the aggregate of the members of its subclasses when these two aggregates are not numerically equal.

Operational logic rejects the extensional theory of classes, and adopts instead the intensional theory.

A *logical proposition* has a logical structure which corresponds to a psychological structure in thought.

A *grouping* (*groupement*) is an equilibrate schema which constitutes the framework for a set of unified operations. For example, classificatory frameworks, serialization frameworks, matrices, family-trees, are forms of groupings. Groupings are psychologically prior to the construction of specific operations. Thus the framework of classification is prior to the operation of class-inclusion, and the framework of serialization prior to the operation of transitivity.

2. Elements:

The formal elements and principles of operational logic essentially correspond to those of axiomatic logic. They are:

(i) Principles:

Principle of identity: If a proposition is true then it is true. Symbolically: $(p)\ (p = p)$.
Principle of contradiction: Any quality of an object may not be affirmed and negated simultaneously. Symbolically:
$(f) - (f(x) \cdot -f(x))$.
Both these principles are considered by operational logic to be particular manifestations of the general "law of equilibrium" (cf. Chapter 5).

(ii) Logical constants:

conjunction (and): " $\cdot$ "
negation (not): "$-$"
implication (if-then): "$\rightarrow$"
biimplication (reciprocal implication): "$\equiv$"
identity (logical equation) "$=$"
inclusive disjunction (either-or or both): "v"
exclusive disjunction (either-or): "w"
negative disjunction (neither-nor): "/"
The number of these logical constants can be reduced by defining all the others in terms of one or two of them. (Frege for instance reduced them to negation and implication). But however pragmatic such a reduction may be from the standpoint of axiomatic logic, it appears to be a very arbitrary reduction from the standpoint of operational logic.

(iii) Quantifiers:

universal quantifier (all): "(∅)" or "(x)" or "(p)"
existential quantifier (some): "(∃∅)" or "(∃x)" or "(∃p)"
particular quantifier (the): "(I∅)" or "(Ix)" or "(Ip)"

(iv) Operators:

logical sum (two classes included in a third): "$+$"
logical product (a third class included in any two classes): "$\times$"
logical subtraction (combination of a class and its inverse): "$-$"
class-membership (object falling under class): "ε"
class-inclusion (class falling under class): "$>$"

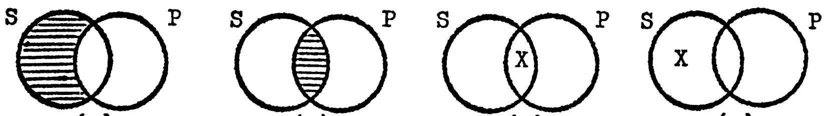
(v) Logical variables:

object variables (terms): "x", "y",...
concept variables (predicates): "∅", "θ",... or "f", "g",...
thought variables (propositions): "p", "q",...
class variables: "A", "B",... (O = null class)
relational variables: "R_1", "R_2",...

The standard categorical propositions are stated very differently in the context of classical logic (Aristotle) and of modern logic (Whitehead & Russell). In the former context, the existential import is assumed and the categorical propositions are stated in terms of classes; in the latter context, the existential import is rendered explicit and the total expression acquires a purely propositional form:

categorical propositions	*classical logic*	*modern logic*
(1)	All S is P	(x) $(\varnothing x \rightarrow \ominus x)$
(2)	No S is P	(x) $(\varnothing x \rightarrow -\ominus x)$
(3)	Some S is P	(Ex) $(\varnothing x \cdot \ominus x)$
(4)	Some S is not P	(Ex) $(\varnothing x \cdot -\ominus x)$

The topological representation of both forms of expression, by means of the Venn diagrams, remains of course the same; the only difference being that the one is represented explicitly and the other implicitly:



(1) (2) (3) (4)

Operational logic employs the techniques of the Boole-Schröder logic of classes. This system of logic permits the expression of the categorical propositions in terms of classes, without involving the problem of existential import, and it is susceptible of an explicit representation by the Venn diagrams. Thus this system manifests the configurational aspect of logic very clearly:
(1) $S\bar{P} = 0$, (2) $SP = 0$, (3) $SP \neq 0$, (4) $S\bar{P} \neq 0$.

(vi) Truth-values:

There are two truth-values, and every proposition has a truth-value.
(1) Truth: "T"
(2) Falisty: "F"

Note.—The truth-table, which is an essential part of the propositonal logic, is hardly utilized in operational logic, which has constructed a parallel schema. Therefore, for comparative reasons, the truth-table, will be presented below in summary form. The truth-table performs two functions: (1) Providing a logical definition of the logical constants; (2) Determination of the truth-value of compound propositions as a function of the truth-values of elementary propositions. (cf. Wittgenstein (369)).

	p q	(p · q)	(pvq)	(p → q)	(pwq)	(p/q)	...
(1)	T T	T	T	T	T	F	
(2)	T F	F	T	F	F	F	
(3)	F T	F	T	T	F	F	
(4)	F F	F	F	T	T	T	

3. System:

From the standpoint of psychology, the formation of *groupings* is necessary for the construction of the logic of classes. And the logic of classes and relations is inturn necessary for the formation of the logic of propositions. Consequently, the startingpoint of operational logic is the logic of groupings and of classes. In contrast axiomatic logic traditionally begins with the logic of propositions (except the system of Boole-Schröder which is essentially a logic of classes anyway). Thus operational logic adopts the perspective of genetic psychology: According to this perspective the conception of classes and relations is formed independently of the conception of propositions, while the formation of the latter presupposes that of the former.

The logical conditions of operational *groupings* are the following:
(i) Combinativity. Any two different elements of a grouping may be combined to form a new element of the same grouping. ($A_1+A_2 = B$) and ($B_1+B_2 = C$) etc.

(ii) Reversibility. Groupings are reversible in that for every operation of a grouping there is an inverse operation. ($B-A_1 = A_2$) and ($B-A_2 = A_1$).
(iii) Associativity. The same grouping may be arrived at by different operational routes. $A_1+(A_2+B) = (A_1+A_2)+B$.
(iv) Identity. An element of a grouping remains structurally constant. ($A = A$) or ($A-A = 0$) or $A \pm B = A$).
(v) Analyticity. When qualitatively identical elements of a grouping are combined they are not transformed thereby into a new element. Thus $A+A = A$. In logic, which is a qualitative science, such combinations result in "analytic groupings"; in contrast to the "iterative groupings" of mathematics in which the combination of identical elements results in a transformation.

When these logical conditions of *equilibrium* are carried over to psychology, they are manifested in the experimental scene as follows:
(1) Two separate responses can be combined into one resulting in a new response.
(2) The response pattern becomes reversible.
(3) The same goal can be reached by means of different paths (in contrast to stereotyped responses).
(4) The response pattern achieves stability and constancy.
(5) The repetition of a response does not alter the psychological pattern of the response itself but only its effect. For, if the pattern of the response were altered, then it would cease to be the *same* response and it could not accurately be said to have been "repeated".

The logic of *classes* is constructed out of the concepts of class and relation. A class, we have seen, is the extension of a concept. The relation between classes may be either of two types—logical addition or logical multiplication. In the one case the third class thus formed is to be called the *logical sum* by which two classes are included in a third; in the other, the *logical product* by which a third class is included in the two. By means of these operations, operational logic passes from the framework of classes to relational lattices which involve classes. For example, let a given class, K, contain two other classes, C_1 and C_2; and C_1 in turn contain the subclasses A_1 and A_2; and C_2 contain the subclasses B_1 and B_2. We will then have the following schema:

- K (plants)
  - C_1 (terrestrial plants)
    - A_1 (vascular plants)
    - A_2 (nonvascular plants)
  - C_2 (aquatic plants)
    - B_1 (flowering plants)
    - B_2 (nonflowering plants)

This classification schema yields four possible class combinations:

$(A_1)\ (B_1)$	$(A_1)\ (B_2)$
$(A_2)\ (B_1)$	$(A_2)\ (B_2)$

That is: (1) vascular flowering plants
(2) vascular nonflowering plants
(3) nonvascular flowering plants
(4) nonvascular nonflowering plants

The lattice corresponding to the logical product of the classes C_1 and C_2 is represented by the following operational structure: $(C_1 \times C_2) = A_1B_1 + A_1B_2 + A_2B_1 + A_2B_2$.

From such basic schemata evolve the operational schemata of the more complex classes and relations.

The fundamental importance of the logic of classes for genetic psychology may be explained in this way. Dichotomous and combinatory classifications are a characteristic feature of the biological sciences (botany, zoology, medicine). And the structural affinity of genetic psychology with these sciences is evident. For it studies the morphogenesis of psychological operations and it looks at its phenomena as a reflection of classes of patterns.

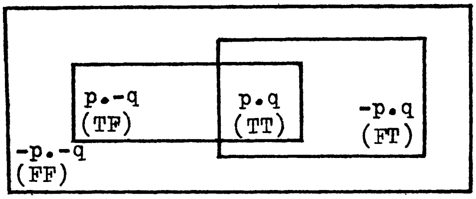
The logic of *propositions* presupposes the logic of classes and relations. The protocol structure of the logic of propositions is a truth-value schema which represents the combinatorial possibilities of binary propositions. And this protocol reflects the general form of the operational lattice corresponding to the combination of classes:

$$\begin{array}{lccccccc}
\text{Classes:} & (A_1B_1) & + & (A_1B_2) & + & (A_2B_1) & + & (A_2B_2) \\
 & \updownarrow & & \updownarrow & & \updownarrow & & \updownarrow \\
\text{Propositions:} & (p \cdot q) & \mathrm{v} & (p \cdot -q) & \mathrm{v} & (-p \cdot q) & \mathrm{v} & (-p \cdot -q)
\end{array}$$

Thus the evolution of concepts, from the logic of classes to the logic of propositions, is *structurally* continuous.

It may be also noted here that there is a structural isomorphy between the protocol structure of operational logic and the protocol structure of the truth-table in modern axiomatic logic. This parallelism may be written as follows:

$$\begin{array}{llllll} \text{Operational} & & & & \\ \text{protocol schema:} & (p \cdot q)v(p \cdot & -q)v(-p \cdot & q)v(-p \cdot & -q) \\ & \updownarrow & \updownarrow & \updownarrow & \updownarrow \\ \text{Truth-table} & & & & \\ \text{protocol schema:} & (TT) & (TF) & (FT) & (FF) \end{array}$$



The *logical constants* are then definable in terms of the two parallel protocol structures as follows:

$$\begin{aligned} (p \text{ v } q) &= (p \cdot q)v(p \cdot -q)v(-p \cdot q) \text{ and } -(-p \cdot -q) \\ &= (TTTF) \\ (p \rightarrow q) &= (p \cdot q)v(-p \cdot q)v(-p \cdot -q) \text{ and } -(p \cdot -q) \\ &= (TFTT) \end{aligned}$$

etc.

Out of the *protocol structure* of operational logic evolve the rest of the propositions by combining the elements of the protocol structure an n-number of times. In this way the transition is made from the elementary propositions to the complex propositions. The complex propositions are characterized by the fact that, unlike the elementary propositions, they are combinatorial. Starting with:

$$\underset{(1)}{(p \cdot q)} \text{ v } \underset{(2)}{(p \cdot -q)} \text{ v } \underset{(3)}{(-p \cdot q)} \text{ v } \underset{(4)}{(-p \cdot -q)}$$

The sixteen basic binary operations of the two-valued logic are constructed out of the various combinations of these elements.

These combinations, represented by the numbers assigned to the elements of the protocol structure, are:

(0) – (1) – (2) – (3) – (4) – (1) (2) – (1) (3) – (1) (4) – (2) (3) – (2) (4) – (3) (4) – (1) (2) (3) – (1) (2) (4) – (1) (3) (4) – (2) (3) (4) – (1) (2) (3) (4).

The corresponding propositional structures are:

1. (o)	2. $(p \cdot q)$	3. $(p \cdot -q)$	4. $p \cdot (q v -q)$
5. $(-p \cdot -q)$	8. $(p \cdot q) v (-p \cdot -q)$	11. $(p \cdot -q) v (-p \cdot -q)$	14. $(q\ p)$
6. $(-p \cdot q)$	9. $(p \cdot q) v (-p \cdot q)$	12. $(p \cdot -q) v (-p \cdot q)$	15. $(p v q)$
7. $-p \cdot (q v -q)$	10. $(p\ q)$	13. (p/q)	16. $(p \cdot q) v (p \cdot -q) v$ $(-p \cdot q) v (-p \cdot -q)$

There are four fundamental *intrapropositional operations*:
(i) The operation of *identity*—which when applied to any propositional operation leaves it unchanged. Example: $(p \cdot q) = (p \cdot q)$.
(ii) The operation of *inversion*—which holds between two propositional operations such that either one is the resultant of the negation of the other. Example: $(p v q)$ and $(-p \cdot -q)$.
(iii) The operation of *reciprocity*—which holds between a propositional operation with a given set of elements and the same propositional operation with the negation of the same set of elements. Example: $(p v q)$ and $(-p v -q)$.
(iv) The operation of *correlativity*—which is the resultant operation whenever, in a propositional operation, a conjunction constant is substituted for a disjunction constant and vice versa. Example: $(p \cdot q)$ and $(p v q)$.

The general operational formula, which governs these intrapropositional operations, is as follows:

$$(p) \quad \left(\frac{Ip}{Rp} = \frac{Cp}{Np}\right)$$

—where I = identity, R = reciprocity, C = correlativity, and N = inversion. The "p" is the propositional variable, and (p) the universal quantifier which ranges over the terms of the operational equation collectively.

Illustration: $(p)\ (q) \quad \left(\frac{p v q}{p/q} = \frac{p \cdot q}{-p \cdot -q}\right)$

The above 16 propositional forms are constructed out of the 4 "binary operations" (operations involving 2 elements). And there are exactly 256 propositional forms corresponding to the 8 "ternary operations" (operations involving 3 elements). It would be unnecessary, for the purposes of the present work, to develope the variations of these forms any further here. Instead, we shall turn to some comparative observations concerning logical theory.

There are some essential theoretical differences between the systems of "operational logic" and "axiomatic logic." According to Piaget (270), the former may be described as a "descriptive logic," since it reflects the morphology of logical operations from the genetic standpoint; and the latter as "normative logic," since its order of construction appears to be rather conventional. It is pointed out, for example, that it makes little difference in axiomatic logic which pair of logical constants are taken as the primitive elements of the system; or, even, that the calculus of propositions is placed before the calculus of classes. It may be observed, in fairness to axiomatic logic, that, while its order of construction appears to be flexible to the point of normative stipulation, nonetheless the completed system is far from being an arbitrary construction. For the contents of axiomatic logic consist of the objective forms of abstract thought, and in this sense, axiomatic logic too constitutes a descriptive science. The essential difference, then, between the two logical systems, consists in that these provide two different perspectives (transverse *and* longitudinal) within the general *science of logic*. However, it is true that, while operational logic is essentially the "psychologist's logic," axiomatics generally neglects the relevant data of psychology. For this reason, among other things, axiomatic logic frequently tends to become extensional and atomistic; while operational logic remains intensional and configurational. Yet, despite the limitations of the former in this respect, the latter is pledged to respect its fundamental laws. For the concept of "logical validity" has a constant meaning in both contexts: Namely, an inference is logically valid if, and only if, it is guided by logical models or regulated by logical principles. Accordingly, all the standard principles of inference are accepted by operational logic from the beginning. However, these same principles, which constitute the ultimate postulates of axiomatic logic, are interpreted by operational logic to be special manifestations of the "law of equilibrium." We shall have the occasion to examine the latter, as the most general psychological law of thought processes, in its proper context later (cf. Chapter 5: I–II).

The twofold objective of genetic psychology, in constructing the system of operational logic, has been: Theoretically, the achievement of a logical synthesis between the rigor of axiomatic logic and the objective data of psychology; and methodologically, to obtain an exact technique of analysis applicable to its experimental phenomena. Whether genetic psychology has achieved these specific objectives remains to be seen. In this chapter our main concern has been the inspection of operational logic as the potential logical methodology of genetic psychology. The psychological phenomena, to be described later, shall provide numerous instances of the application of operational logic (cf. Chapter 4). The critique of operational logic, by contemporary logicians, has sofar been confined to the matters of detail rather than matters of principle. A representative example is the critical review by C. Parsons (145) of Harvard University. The criticism generally centers about the deficiencies of the system in point of completeness and of neglecting the more conventional usages. While the justification of much of this criticism may be acknowledged, it may nevertheless be observed that the theoretical perspective of operational logic is defencible upon scientific as well as logical grounds, that its application to the interpretation of psychological phenomena has been greatly demonstrated, and that, consequently, the shortcomings of detail must not prevent us from appreciating the structural perspective and the methodological utility of this system. And let it not be thought that the faults of detail are necessarily the products of a faulty perspective; every logical system has its own set of specific deficiencies and perhaps shall remain forever incomplete. Furthermore, it must be remembered that the operational logic is not an alternative to the standard system of logic but rather its complementary. A basic critique of the operational logic must consist of a logical analysis of the basic concepts upon which it was built (e.g. concept of structure); and we shall undertake such an examination in the philosophical part of this work (cf. Chapters 7 & 8).

CHAPTER 3

PHENOMENA OF PERCEPTION "WHY DO THINGS APPEAR AS THEY DO?"

The experimental and theoretical study of perception and of thought processes, in the last analysis, constitute the core of academic psychology. And, as we have noted earlier, gestalt psychology and genetic psychology (especially the French Phase) both are essentially concerned with the nature of cognitive processes in the larger sense. The history of the recent revolution in the psychology of perception (as well as cognition in general), brought about by the *Gestalttheorie*, has been already written. It was written at first by the leading gestalt psychologists themselves, notably K. Koffka (167) and W. Köhler (173) in America; and by P. Guillaume (1937) and J. Elmgren (1939) in Europe; and it has been written again by the critical historians of psychology, namely E. G. Boring (39) (40) and F. H. Allport (7). This author will refrain from rewriting this famous history here; but, instead, will examine the structure of the gestalt theory of perception from the comparative standpoint. Far less, however, is known about the genetic theory of perception, and its relationship to the gestalt theory. For genetic psychology is interested primarily in the nature of thought processes, and only secondarily in perception; since it investigates perception, not *per se*, but in order to throw more light upon the ontogeny of thought processes, from the angle of the partial isomorphism that obtains between the two sets of processes. Our objective in the present chapter, then, will be to examine the phenomena of perception in the light of the gestalt theory and the genetic theory, and to determine the relationship between these theories, which are affiliated beyond the level of mere complementarity and corroboration, and hence the full comprehension of the latter necessitates that of the former. Whatever epistemological significance these psychological theories may possess, beyond sundry overt connections, its analysis will be reserved for the philosophical part of this treatise.

I. THE GESTALT THEORY OF PERCEPTION

It is a psychological fact that things do *not* always appear as they actually are, and that perceptual illusions are *real* phenomena. The basic problem of the psychology of perception, then, is to explain why things appear as they do. It may be noted that we will not be concerned here with the epistemological problem of perception: Namely, that even if things always did appear as they really were, how would we know that they *really* were what they *appeared* to be? For appearance and reality may not be the same; and even if they were the same, we would have to cross the epistemological bridge from one to the other, in order to discover the alleged identity of appearance and reality. This is essentially the problem of our knowledge of the "external world" in contrast to our knowledge of the "given world." We shall have the occasion to investigate this problem in an epistemological context later (cf. Chapter 9).

That psychology has achieved the systematic continuity characteristic of a natural science is nowhere more evident than in the area of perception. The basic problem of perception, with which this chapter begins ("Why do things appear as they do?"), was first examined in classical German and American psychologies (W. Wundt and Wm. James), was shortly after investigated by gestalt psychology (K. Koffka and W. Köhler) in a systematic way, was reinterpreted in recent American psychology (F. H. Allport), and lastly, genetic psychology (Piaget) has quite naturally undertaken the study of this problem without explicitly formulating it. Genetic psychology, in fact, formulated a different problem, namely, "What is the relationship between the process of perception and the thought processes?", and its solution to the former problem turned out to be the critical biproduct of its solution to the latter problem.

Before the rise of gestalt psychology, William James (146: chapters 7 & 19) suspected that something was fundamentally wrong with the elementary psychology of classical empiricism (Locke and Wundt), and this theoretical diagnosis led eventually to the termination of the influence of the British School upon American psychology. For James demonstrated that discrete "ideas" could not come and go, over the threshold of perception, without any perceptual unity and a unity of apperception; and that the problem could not be solved by invoking the doctrine of "association" merely, for discrete ideas could not possibly associate, *if* the mind consisted of *nothing but* discrete ideas, nor would there be any "laws of association" or even a *consciousness of* this association after the fact. James observed that all perception is an "acquired," and hence a "figured," process; and that we only "see" things which we have in a sense "preperceived." Thus, by drawing attention to the structuring aspect of perception, James inaugurated a general viewpoint for which Thorndike (337) describes him as the forerunner of the modern psychology of perception and thought processes. In any case, after James had demonstrated the erroneous nature of the "representative theory of perception" according to which our "ideas" are the exact "copies" of external objects, it was but a short theoretical step to the formulation of the real problem of perception: Why do things appear as they do?

The explicit statement of this problem was made in the context of gestalt psychology. It was Koffka (167) who asked, "Why do things look as they do?", and he argued as follows: Things look as they do, *not* because the *proximal stimuli* (microscopic stimuli) are what they are, for, if this were the case, then it would follow that, (a) any change in the proximal stimuli would produce a change in the appearance of objects, and, (b) no change in the appearance of objects would occur without a corresponding change in the proximal stimuli. However, neither of these two consequences is true. That (a) is not the case is evident from the phenomena of subliminal proximal stimulation which has been demonstrated by psychophysics: The range of the variation of the stimulus dimension extends considerably beyond the range of the variation of the perceptual dimension. That (b) is not the case is evident from the phenomena of perceptual inconstancies (e.g. variations of optical illusions) which indicate changes in the appearance of objects without a corresponding change in the proximal stimuli. The logical conclusion, arrived by Koffka, was that things look as they do because the *distal stimuli* (macroscopic stimuli) are what they are. And since the distal stimuli correspond, roughly speaking, to "perceptual gestalten," the gestalt psychologists proposed that the study of "gestalten" must be given the central place in the psychology of perception. Even from the epistemological standpoint this proposal appears to be perfectly sound: For, since perceptual configurations are the only things that come before our perception, we could not assign to them a peripheral place in any case.

A *gestalt* (configuration) is to be described as a psychological structure, being constituted out of a set of elements and relations, and displaying a quality not possessed by its constituents. The old formula, to the effect "the whole is something more than the sum of its parts," may be stated more exactly as follows: The whole is something more, as a combinatorial proportion, than the additive aggregate of its elements (parts and relations). What is *more* consists of the *emergence* of a new quality (in the case of the perceptual gestalten) or of the *transcendence* of the gestalt relative to its elements (in the case of the cognitive gestalten). The concepts of "emergence" and "transcendence" will be explained by distinguishing the two corresponding types of gestalten:

(1) Gestalt as *percept* which we shall refer to as the Ø-gestalt. The main trait of this type of gestalt is that it possesses at least one property which is not possessed distributively by its elements (parts and relations). This property is a psychologically emergent property. The class of phi-phenomena constitutes the classic illustration of the Ø-gestalten: For example, the phenomenon of apparent movement (Wertheimer (360) and Oppenheimer (243)), the phenomena of relative velocity (Johansson (150)), the phenomena of color contrast (Katz (163)), and the phenomenon of the anisotropy of space (the gamma-movement) (Ellis (82)).

(2) Gestalt as *concept* which we shall refer to as the θ-gestalt. This type of gestalt is obtained from the inspection of a set of Ø-gestalten by the process of "constructive abstraction" (cf. Chapter 7: I). The main trait of the θ-gestalt consists of the transcendence of its abstract pattern relative to any set of particular elements. And the phenomenon of the *transposition* of gestalten is to be interpreted as the structural product of structural transcendence. Hence, the θ-gestalt, as a conceptual system of elements, remains constant when the values of its elements are varied in the same proportion; that is, it remains the same even after all its parts have been replaced. The phenomena of transposition observed by Köhler (173), by Klüver (165), and by Harlow (122), are illustrative of the formation and functioning of the θ-gestalten. Accordingly, from the methodological standpoint, the θ-gestalt may be regarded as a theoretical construct which explains the phenomenon of transposition. It may be noted that the phenomenon of the "reversal of transposition," which Spence (324) has observed in the behavior of chickens, indicates nothing more than the fact that the permanence of the θ-gestalt is relative to the levels of the phyletic scale corresponding to the relativity of intelligence. The higher we rise in the phyletic scale, the higher the level of intelligence, and the more permanent the abstract gestalten.

It is reasonable to expect, then, that there will be a less proportion of the reversal of transposition in the apes than in the chickens, far less in the children, and that there will be none in the rational man as the prototype of the *homo sapiens*. Accordingly, such studies, instead of refuting the hypotheses of the gestalt theory as they have been erroneously interpreted to that effect, in fact corroborate them.

It may be observed that the two types of gestalten in the family of gestalten, namely "perceptual gestalten" (Ø-gestalten) and "conceptual gestalten" (θ-gestalten), belong to the two realms of perception and thought processes respectively. Further, it may be observed that each type manifests variations of "weak" and "strong" gestalten, corresponding to their relative degrees of structural equilibrium respectively. And the concepts of "gestalt" and "equilibrium" constitute the bond of transition from the gestalt theory of perception to the gestalt theory of thinking and imagination. The dichotomy of gestalten which we have described corresponds to the logical analysis of the concept of gestalt given by Grelling and Oppenheim (114)—the main difference being that these authors attend solely to the methodological aspect of this dichotomy neglecting its phenomenological content. The problem of the reducibility of the concept of gestalt to the elementary concepts of a physicalist language will be examined later (cf. Chapter 7: II).

Returning to the dichotomy of proximal-distal stimuli, we may now inspect it in the light of the concept of gestalt. Gestalt psychologists (notably Köhler (173)) have time and again pointed out that the adherents of the physicalist theory of perception (sensationism) use the term "stimulus" too loosely. According to this theory, the percept may be regarded as the aggregate of the units of sensation that enter the receptor and follow the path of the afferent nerves. Hence, perception is described as a sensation which has been noticed; and the sole difference between sensation and perception is attributed to the consciousness of the subject. Consequently, the physicalists tend to speak of the "proximal stimulus" when they intend to mean the "distal stimulus," and conversely. And the apparent credibility of their viewpoint is the result of the hidden ambiguity of its basic concept (stimulus). Gestalt psychologists have stressed that the gap between the proximal and distal stimuli is too great to be slurred over in this fashion, and that the cognitive path that leads from the sensation to the perception consists of a complex psychological process. This gap consists of the apparent discrepancy between the percept and the object; for, as we have observed, objects do not always appear as they really are; and to explain this discrepancy is the basic problem of the theory of perception. The gestalt theory suggests that the gap between the sensation and the perception is the product of the intervention of the psychological framework of the subject during the interval between the sensation and the perception. As a psychological process this intervention consists of the construction of the percept out of the elements of the sensation in the form of a gestalt (Ø-gestalt). The proximal stimulus is thus transformed into the distal stimulus in the subject; and the subject in turn always responds to the latter and never to the former. This hypothesis is illustrated by Wertheimer (361: p. 301) in a well-know passage: "I stand at the window and see a house, trees, sky. Theoretically I might say there were 327 brightnesses and nuances of color. Do I *have* '327'? No. I have sky, house, trees..." According to the gestalt theory, then, the formula for perception may be written as follows:

$$R = f(S_g = f(S_s)O)$$

Where R = response pattern, S_g = distal stimulus, S_s = proximal stimulus, and O = psychological framework of the subject. The formula describes the formation of the perceptual gestalten, out of the elements of sensation, within the psychological framework of the subject (including the *Einstellung*). The process of perceptual gestalt-formation is generally regulated by the principles of figural organization (Wertheimer (361)): Notably, the principles of proximity, similarity, continuity, and frame of reference. And the direction of this process is regulated by the *principle of prägnanz*, according to which every configuration, given its relative level of equilibrium, tends to attain a constant degree of equilibrium. The conception of the "bad figure" and the "good figure," in the context of the gestalt theory, is to be interpreted in the light of the principle of prägnanz. The diagram representing the gestaltist view of the process of perceptual transformation is given in Figure I.

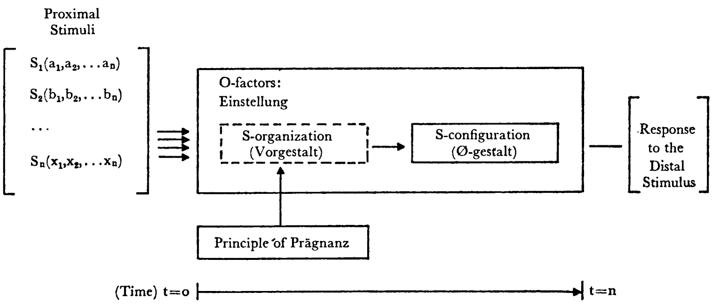
The theoretical problem that remains in the last analysis is the following: If the gestalt in any perception whatever is *not* given *with* the proximal stimuli, then what does this gestalt consist of over and above these? That is, from the beginning of the "vorgestalt" to the completion of the "gestalt," what is it that the process of gestalt-formation *adds* to the original material of sensation? According to the gestalt theory, since the gestalt-formation consists of a psychological transformation of sensation into perception, the essential factor is the "synthetic relationship" which constitutes the determining principle of the combinatorial possibilities of the elements and their elementary relations. The result of this synthetic transformation is the emergence of a "gestalt quality" (*Gestaltqualität*) not possessed by the elements analytically considered.

The "synthetic relationship" inherent in the gestalt consists of the *combinatorial proportion* of its elements. To give an example: A set of tinker-toys, dispersed on the table, consists of the elements and their elementary relations, before the reconstruction; however, after the reconstruction, the evolving of a structure, manifesting a "synthetic relationship," introduces a gestalt quality into the scene. Since this gestalt and its quality is a function of the given elements and the psychological framework of the subject, the variations of gestalt-formation may be explained with reference to the ramifications of the psychological framework of the subject. Two friends out for a walk may look at the dark clouds in the distant horizon, and, unless they are confirmed pragmatists, both might overlook the fact that these clouds signify a storm, but are attracted by what they reportedly "see": The artist perhaps sees the huge black cat described by the poet Morgenstern, and the alpinist the bleak mountain range where he had once crawled for his life. To the one the dark clouds actually "look soft," to the other actually "hard." Similarly, gifted muscians perceive the color patterns of polyphonies, and ascribe various hues to different tones. And the phenomenon of synesthesia (sensory complication), which James (146) described by his "law of coalescence," turns out to be a special progeny of the general process of associative gestalt-formation.

The problem of the relativity of perceptions is related to the problem of perceptual illusions. For, if it be the case that perception is determined, not by the properties of the external object exclusively, but also by the subject's psychological framework, then the question arises: What is the real difference between veridical and illusory perceptions, and by what *criterion* must we separate these two classes of phenomena? From the epistemological standpoint, the distinction between the veridical and illusory phenomena is purely a phenomenological distinction (cf. Chapter 9). And in the naturalistic context of psychology, it appears that the twofold criterion of "minimum distortion" and "maximum constancy" is both adequate and sufficient (cf. Köhler (173) and Allport (7)).

Some cases in experimental psychology may serve to illustrate the application of the criterion of objectivity to the problems of perception. That in decreasing illumination the red colors become relatively darker and the blue colors relatively brighter (Purkinje); or that two patches of gray of equal intensity do not appear equally bright against different backgrounds (Rubin); such phenomena, and others similar to these, have become the commonplaces of experimental psychology. Their explanation, however, is a different matter. It was James (146) who first pointed out that what we perceive is actually the "ratio" of the sensations rather than their absolute values (properties and quantities). Since then gestalt psychology has demonstrated that the relativity of the perception of colors is a function of both light *and* chromatic context (Koffka (167)). More recently, an experiment by Wallach (348) has shown that the apparent brightness constancy of the achromatic colors is a function of the "ratios" of the brightness intensity of the figure and the ground. Two theoretical results follow from these experimental observations: Firstly, that the *constant gestalt* is determined by a set of combinatorial ratios; and secondly, that the set of combinatorial ratios is embedded in the *figure* and *ground* relationship. And since according to the gestalt theory the latter principle has an universal application to the phenomena of perception, it is to be attributed to the merit of the gestalt theory that the perplexing phenomenon of the "moon illusion" has been explained on the basis of the principle of the "figure and ground." The phenomenon consists of the fact that the horizon-moon always appears to be considerably larger than the zenith-moon, despite the fact that the zenith-moon is geometrically nearer the observer and that consequently its retinal image is relatively larger. It may be observed that the problem of the "moon illusion" is a special case of the general phenomenon of the "perspective illusion." The latter consists of the fact that the apparent size of the object is always a function of the apparent distance of the same from the observer. Consequently, the factors infuential in the perception of distance determine, indirectly, the perception of the object. Accordingly, J. J. Gibson (104), in his work concerning the perception of the spatial world, has demonstrated that the structural aspect of the background, against which the object is seen, affects the apparent size of the object, by the representation of the relative degrees of distance. Theoretically, then, the solution of the problem of the "moon illusion" may be derived from the general principles of the phenomenon of the "perspective illusion." And the recent experimental study of the "moon illusion" by Rock and Kaufman (cf. *Science* (1962)) represents precisely such a derivation: When the landscape, stretching between the observer and the horizon, was concealed from the subject, the illusion disappeared (the apparent size of the horizon-moon diminished); when the image of the zenith-moon was projected to the horizon across the spatial landscape, by means of a set of mirrors, the illusion reappeared (the apparent size of the projected zenith-moon increased). It was concluded that the degree of the illusion depended upon the extent of the perceived distance between the observer and the object. It would be easy to construct a geometrical schema, according to the principles of perspective, consisting of a ground network and a pair of identical figures in the foreground and the background; then it will be seen that the figure in the foreground appears to be smaller than the figure in the background. The older explanation of the "moon illusion" had been in terms of the movements of the visual organs; but, from the methodological standpoint, a pyschological explanation of a psychological phenomenon is always to be preferred to a physiological explanation of the same. Of course, this is not to say that the establishment of parallelisms between the physiological and psychological explanations is not highly valuable. In any case, it is sufficient for psychology to have empirically determined the *constancy* of these perceptual phenomena, and to have explained the apparent *distortions* of the same with reference to an objective context.

The theoretical explanation of the phenomena of optical illusion, in the context of gestalt psychology, is formulated in terms of the concepts of *trace* and *aftereffect.* Köhler and Wallach (185) have discovered that, if a region of the visual field be occupied by a figure for a period of time, and if another figure is shown in the same region immediately afterwards, then the latter will generally appear distorted or displaced. Generally, the degree of the distortion or the displacement represents the amount of the aftereffect of the first figure upon the second figure. The aftereffect itself is the product of the trace. Without tracing here the complex fate of the "trace" in contemporary research, it may be noted that it correponds to the "engram" in the context of functional psychology. The trace, left behind by a perceptual configuration, has an aftereffect upon a succeeding figure. And, in the absence of the succeeding figure, the aftereffect is transformed into the *afterimage.* Under special circumstances, when the figure consists of a complex configuration with more than one center of equilibrium, the same figure may have an aftereffect upon itself. The structure of the figure may be such that a portion of it, standing out prominently relative to the rest of the figure, will invite the focus of attention earlier. When, afterwards, the rest of the figure enters into the field of perception, it will show the effects of the aftereffect of the preceding trace of the prominent portion of the figure. And this aftereffect results in the distortion or displacement of part of the figure relative to its other parts. This, then, is what actually happens in the perception of optical illusions. For example, in the Mueller-Lyer illusion the diagonal lines, being the prominent parts, distort the horizontal lines which are the subsidiary parts. And, as Köhler and Fishback (182) have demonstrated, this illusion can be destroyed, by repeated exposure, since the perceptual trace of the weaker portions will gradually approach the maximum intensity attained by the trace of the stronger portions. Since the trace of the figure is, like the figure itself, a gestalt; the aftereffect of part upon part results in a "distorted gestalt." An illusion, then, may be described as a gestalt which is partially overestimated and partially underestimated. And overestimation and underestimation are the essence of the illusion; for, in the one case what appears is not actually there, and in the other case what is there does not appear but remains hidden. Let us conclude that the gestaltist interpretation of the phenomena of perceptual illusion remains essentially a valid interpretation, leaving aside the facile criticism resulting from misunderstandings, and that this inherent validity is reinforced by a fresh set of evidence: We refer to the experimental phenomena of "perceptual transformations" and "perceptual adaptation," discovered by Ivo Kohler (168) at the Universität Innsbruck as a result of his experiments with prism goggles.



(Gestalt Schema of Perception)

General Conclusion

To the question, "Why do things appear as they do?", we may now answer, that the appearance of objects in perception is the product of a *synthetic process*. And there are two sets of factors which constitute the necessary conditions of this synthetic process: Firstly, the *objective structure* of the object, that is, the constancy of its objective properties. Secondly, the *psychological framework* of the subject, that is, the system of "cognitive structures" as well as the "set" of the subject. The system of cognitive structures corresponds, variously, to the system of "cognitive gestalten" (gestalt theory), of "abstract operations" (genetic theory), and of "selective schemata" (ethological theory). The process of perceptual synthesis, given the necessary factors, is regulated by the psychological *laws of perception*. This, then, constitutes a sketch of the outlines of the revolution in the psychology of perception. The theoretical consequences of this scientific reorientation, within psychology proper and within epistemology, are highly significant.

Perception is a synthetic and structuring process; and both the "sensationist theory" and the "learning theory" of perception must be critically reexamined in the light of the structural interpretation. That perception is not a learning process, as it is sometimes maintained by modern behaviorism, has been demonstrated by the experimental study of the various perceptual phenomena (especially phi-phenomena and optical illusions). That perception is not a passive process, which reproduces identical copies of external objects, is equally evident. Traditional psychology, under the influence of the British School (Locke and Hume), maintained that perception was a perfectly passive affair, in which the percepts passed unscreened through the receptors and impressed themselves upon the "plain tablet" of consciousness. Now, in the light of the contemporary psychology of perception, there are at least three errors in this doctrine: First, sensations do not pass unfiltered through the receptors; second, there is no "plain tablet" at the afferent end of the receptor upon which the sensations are supposed to impress themselves; and third, consequently no passive impressions are formed in perception. To Locke's much-cited dictum, that "Nothing is in the mind that was not in the senses," Leibniz had replied, "—except the mind itself," and the epistemological issue had hung there till the days of Kant. It was the objective of Kantian philosophy to demonstrate systematically what was provided by the "senses" and what was contributed by the "mind" toward the synthesis of knowledge. The great argument of Kant was to the effect that, there was no doubt that all knowledge *began* with experience, but that it did not follow from this fact that all knowledge was *derived* from experience. For the material of experience, which is given through the sensation, is structured by the forms of perception, and subsequently organized by the categories of intelligence, which remain innate frameworks in the mind. Comparative psychology furnishes abundant empirical evidence for the epistemology of Kant, ranging from the limited perceptual framework of the frog to the limited conceptual framework of the ape. And the modern psychology of perception displays a profounder theoretical affinity with the Kantian epistemology than with the Lockean epistemology and his modern followers. However, the essential difference remains in that, while the

Kantian epistemology, like all philosophical theories, provides an *a priori* explanation of perception, the psychological explanation is strictly from the empirical standpoint. Thus it is evident that scientific empiricism need not always be in alliance with elementism, but is logically compatible with structuralism, even though this is not always recognized in contemporary philosophy. In any case, structuralism constitutes the essential theoretical affinity between the two psychological schools with which we are concerned. For, the genetic theory of perception, which adopts the basic propositions of the gestalt theory, assumes a complementary perspective relative to the latter; and the same hypotheses, demonstrated by the one from a purely morphological standpoint, are investigated from the genetic standpoint by the other.

The theoretical interpretation of the process of perception by gestalt psychology has brought about a revolution in science. Summarily formulated, this theoretical revolution has resulted in two things: Firstly, the empirical investigation and the theoretical explanation of a remarkable set of phenomena; and secondly, by assigning a critical role to the concept of "structure," a methodological reorientation in psychology in general. We have examined the former contribution in the preceding pages; and we shall examine the latter contribution later (cf. Chapters 7 & 8). These contributions of gestalt psychology have exerted a profound and pervasive influence upon European psychology as well as American psychology. In America, gestalt psychology was partially responsible for the renaissance of functionalism, which seeks a methodological synthesis between the quantitative and qualitative methods. The work of F. H. Allport (7), which considers the concept of "structure" to be the fundamental explanatory idea in the psychology of perception, and which argues that "qualitative laws" are logically complementary to "quantitative laws," is to be understood in this light.

The theoretical effect of gestalt psychology upon psychological research in Europe in general has been profound and pervasive. The range of this effect extends from ethological psychology (represented by Lorenz (206), Tinbergen (339), and Rensch (300)), to physiological psychology (excepting the Soviet School), to genetic psychology (in its German, French, and Northern phases). Indeed the hypotheses of the German Phase of genetic psychology, which describes itself as "*genetische Ganzheitspsychologie*," presuppose the principles of gestalt psychology (cf. Thomae (336 & Haseloff (126)). In the north, the researches of Buytendijk (53) (54), School of Utrecht, are especially important in that, not merely they provide a sound physiological basis for psychological theory, but also interpret the phenomena of genetic psychology from an integrative and configurational standpoint. However, the influence of gestalt psychology upon the French Phase appears to be relatively implicit albeit substantial. The relationship between these may be described as a case of unilateral symbiosis, since the School of Geneva has derived two of its fundamental concepts from the *Gestalttheorie.* Consequently, in a recent review of the *Gestalttheorie,* Piaget (272) concludes that the concept of the "structure totale" (*Gestaltbegriff*) and the "principe de l'equilibre" (*Prägnanzprinzip*) constitute the permanent contributions of *Gestalttheorie* to the psychology of perception and thought processes. It may be noted that, while the principle of prägnanz generally receives an adequate interpretation in the context of the School of Geneva, this is not the case with the concept of gestalt. For Piaget and his collaborators tend to limit, arbitrarily and unnecessarily, the meaning of the concept of gestalt to "perceptual configurations" exclusively; and, as it will be seen, this is an indequate interpretation. In any case, so deeply rooted is the theoretical relationship between gestalt psychology and European genetic psychology, that a full comprehension of any phase of the latter, apart from the essentials of the former, would be impossible.

A Note on the Set Theory

The gestalt theory of perception stressed, among other things, the intervention of the "set" (*Einstellung*) in the process of perception. Following this hypothesis, a group of functional psychologists undertook the investigation of the nature of the *set*: What were the psychological factors that constituted the set, and what were the differential effects of these factors upon perception? The startingpoint of the factor analysis of the set was a series of experimental studies which demonstrated that a set of hitherto unsuspected antecendent variables were the determinants of perception (cf. Allport (8: ch. 13–15)). It was observed that psychological needs (e.g. hunger), values (aesthetic and ethical), and emotions (e.g. fear), all determined, in various ways, the range and frequency of perception. These experimental studies have resulted in a viewpoint which we shall call the "set theory."

Of the various experiments on the set it will be sufficient to mention three. In one experiment (Levine & Coworkers), a number of drawings of ambiguous objects, placed behind a ground-glass screen, were presented t o subjects who were deprived of food for varying intervals of time; the result was that the association of the ambiguous figures with food objects had a greater range and frequency in the experimental group relative to the control group. In another experiment (Postman & Bruner), words of valuation were presented to subjects, by the tachistoscope, with a duration range between 0.01 second and the absolute threshold; the results showed that the threshold of visual perception was inversely related to the subjective rank of the value category, that is, the higher the value of the category to which a word belonged the less the corresponding time required for its perception. In a third experiment (Bruner & Goodman) two groups of ten-year old children were the subjects: The experimental group was required to estimate the sizes of American coins by the method of average error, and the control group was required to perform the same task using wooden discs instead of coins; the results showed that the experimental group overestimated the sizes of the coins relative to the control group, and that the poor children overestimated the sizes of the coins relative to the wealthy children. These novel results, allegedly startling in their significance, are among the commonplaces of introspective psychology. Everyday observations furnish us with multifarious illustrations of the operation of cognitive and emotive factors in perception. To children, whose spatial conceptions are still in the nascent stage, toys and cookies always look bigger than they do to us, and this fact augments the importance of these objects to them. Let the psychologist compare notes with his observant wife, after the preliminary examination of a prospective residence, and the systematic and thoroughgoing discrepancy will be noteworthy. Descriptive anthropology has reported repeatedly the ways in which the world of primitive peoples is different from ours; and this difference is not explained by the mere fact that they do not look *at* things the way we do, for the fact remains that things do not look *to* them as they do to us. And even to us things do not always look as they are: In the presence of vague patterns, our perceptual vision generates images which reflect our state of consciousness and which in turn make their impression upon our consciousness.

According to the set theory, the determinants of perception consist of: (a) the "formal factors," that is, the structure of the object and its context; and (b) the "functional factors," that is, the motivational factors. The representative statement of the set theory has been given by J. S. Bruner (47) of the Center for Cognitive Studies at Harvard University. Beginning with an analysis of "perceptual readiness," the process of perception is described as an operation whereby input is sorted out into appropriate subjective "categories" and gated from others. The proper function of perception consists of the identification of objects in the environment and the reduction of the element of surprise in experience. The precondition of successful perception is "perceptual readiness," which consists of the "accessibility" of perceptual categories. The latter, in turn, is a function of the "subjective set" (motivational factors) and of "perceptual expectancy." Accordingly, the greater the subjective expectancy for an event, the more accessible the corresponding category; and without the appropriate set, the perception of an event may not take place fully or not take place at all. It follows that there are degrees of the accessibility of categories corresponding to the degrees of their dominance: The more accessible categories, being the more dominant, often "mask off" the less accessible ones. The phenomena disclosed by the experiments concerning set are explained by the set theory with reference to the notions of "perceptual decision" and "perceptual defence"; for perception, it is maintained, screens out what is of negative value to the subject. What happens in the case of "perceptual defence" is that the relative categories become inaccessible by being masked off by more dominant categories. Veridical perception consists of a two-way correspondence between the object and its category, such that the subject is able to infer and predict the unseen properties of the object from the given category. In the case of perceptual illusion, however, there is only a one-way correspondence between the object and the category; for, while the object appears to evoke the category, the category does not define the object completely. It may be noted that, in the context of the set theory, the problem of perception is reduced, in the final analysis, to the problem of "categorization." Accordingly, we may ask: What is the nature of these "categories"? Evidently, they are not to be interpreted as the Kantian "forms of perception"; for the latter are concepts of the highest generality, like space and time, and they are *a priori*. Perhaps it would be more correct to interpret the "categories" of the set theory as a subjective manifold of classification. And, since these "categories" are empirically obtained, a logical circularity appears to result: The formation of the categories presupposes perception (observation of cases), and perception (categorization) presupposes the categories. Further, the set theory appears to imply that perception is a *genre* of learning, an hypothesis which we have found to be psychologically untenable. In any case, not merely the nature, but also the ontogeny of these "categories" remain doubtful. It is for this reason that genetic psychology, which is concerned with the investigation of the genesis of perceptual schemata, remains dissatisfied with the set theory (cf. Piaget and Morf (285)). Likewise, the limitations of the set theory from the standpoint of gestalt psychology are noteworthy.

As a general critique of the set theory of perception, it may be observed that it assigns to the "subjective set," as a determining factor, too pervasive a function in perception. Hence, the set theory, magnifying the role of the set beyond its strict limitations, remains overshadowed by motivational factors. And the peculiar terminology of this theory (e.g. "perceptual decision" and "perceptual defence") may be attributed to the fact that the subjective set is considered to be the main determinant, if not the sole determinant, of perception. But even if the subjective set be correlated to subjective values, it is still beyond the framework of perception to eliminate the elements of surprise in experience, that being the special function reserved for the thought processes. Further, even if there be a partial parallelism between the processes of perception and thought (as both the gestalt theory and the genetic theory have demonstrated), there is a great psychological divergence between the two processes. In any case, it is evident that perception is far from being completely determined by the set, that the set is not even the critical factor in many cases of perception, and that the "objective structure" of the object as well as the "cognitive framework" of the subject, following the laws of perception, define the limits of perception. Numerous experimental studies provide empirical evidence for this generalization: The cognitive framework of the frog is limited to four perceptual categories (achromatic contour, pervasive darkness, linear movement, and random motion); Archer (18) has demonstrated the logarithmic effect of the units of information upon the identification of visual patterns; and Asch (20) has shown that the perception("impression") of personality is determined by configurational principles. It is commonplace that the perception of geometrical figures, which display a high degree of perceptual constancy, appear to be wholly independent of the subjective set of the perceiver. According to Wallach (350), there is an ingression of the functional meaning in the perceptual structure of the object, and this ingression is produced by the same process of association which operates in the case of cognitive recollection and which is based upon the continuity of the trace. Perhaps much of the experimental observations of the set theory could be explained with reference to the principle of associative complication, in the case of the ambiguous figures, and the principle of prägnanz, in the case of the relatively well-defined figures, within the context of the perceptual framework of the subject. Hence the observation of Köhler (82: p. 58): "No one doubts that past experience is an important factor in some cases, but the attempt to explain all perception in such terms is absolutely sure to fail, for it is easy to demonstrate instances where perception is not at all influenced by past experience." We may, then, state our conclusion in the form of a general law of perception: The percept is a function of a combinatorial ratio of complementary components, comprising the properties of the object and the set of the subject, which are susceptible of compensatory variation according to the principle of minima and maxima. Two corollaries follow from this law: (a) That, in the case of the ambiguous figures, where the objective properties approach the minimum, the influences of the set approaches the maximum; (b) That in the case of the geometrical figures, where the objective properties obtain a maximum degree of precision, the influence of the set approaches the zero. Accordingly, the set theory is to be regarded, not as an alternative to the gestalt and the genetic theories, but rather as a supplementary study of the set, with a limited value within the larger framework of the psychology of perception.

II. THE GENETIC THEORY OF PERCEPTION

The main objective of genetic psychology in investigating the phenomena of perception has been to study the relationship between perceptual processes and thought processes (cf. Piaget & Coworkers (279)). For, according to the genetic theory, although these two processes involve very different operations, yet there is a "partial isomorphy" between the perceptual structures and the conceptual structures. And whatever it is that this psychological school has discovered concerning the nature of perception *per se* is to be interpreted in the light of its stated theoretical objective. The genetic theory accepts, at the outset, the main thesis of the gestalt theory to the effect that perception is a synthetic process resulting in configurations. However, the process of perception, in the context of the genetic theory, is described in terms of the concept of "assimilation." The determining factors of this process, which we shall examine in greater detail, consist of the structural properties of the object, the anterior structures implicit in the psychological framework of the subject, the network of centration tactics, the series of perceptual strategies. and the principle of equilibrium. The problem of the relationship between perception and thought processes may be formulated in terms of the genetic and epistemological interaction between the two processes. There are two general phases relative to this relationship, namely dichotomies and affinities, and these will be examined in the following.

1. The Borderline Between Perception and Thinking

The processes of perception and thinking involve very different operations; and this difference manifests itself in a set of dichotomies which defines the psychological borderline between perception and thinking (cf. Piaget (266) (273)):

(i) Representation and abstraction. Perception represents the phenomena, to consciousness, after a synthetic transformation of the sensations. The process of perceptual representation is always confined within a given context of space, time, quality, quantity, and relation. For, as Piaget has observed, operations from a *distance* is the constant mark of intelligence and abstract thought, while perception is always a *proximate* affair. When perceptual representation is interiorized, it becomes imagination (e.g. the "mental experiment"). And imagination, in this sense, constitutes the transitive state between perception and abstract thinking. For imagination, in its representative aspect, is continuous with the concreteness of perception; and in its spontaneity, continuous with the power of abstract reflection. The thought, after reviewing a series of concrete images, reconstructs their abstract morphology in the form of a general concept. Thus, while the synthetic and representative process of perception results in percepts and images, the constructive abstractions of thought result in the attainment of concepts and ideas.

(ii) Percept and concept. A *percept* is a perceptual structure, which consists of the synthesis of a set of elements into a whole possessing an emergent property, that is, a gestalt. Perceptual structures are not analyzable into their constituent elements without remainder. Piaget expresses this condition by describing perceptual structures as "irreversible structures." The structures of thought (*concepts*), in contrast, are abstract operations which fulfill all the formal conditions of equilibrium including analyticity which implies reversibility. (The concept of *structure* will be analyzed in Chapter 7).

(iii) Constancy and equilibrium. Perceptual structures tend to attain a relative degree of constancy. The genetic theory would agree with the thesis of the gestalt theory that "bad figures" tend to become "good figures." But perceptual *constancy*, which is a state of relative stability, is very different from the *equilibrium* attained by the operations of thought. For perceptual structures meet none of the formal conditions of equilibrium—combinativity, reversibility, associativity, identity, analyticity (cf. Chapter 2: II).

The borderline between perception and thinking is then to be traced through a set of three dichotomies—between percept and concept, between representation and abstraction, between constancy and equilibrium. The difference between perception and thinking lies in their processes, their products, and the fate of their products. Having described this difference, we may now turn to the affinity between perceptual processes and thought processes.

2. Partial Isomorphy between Perceptual Structures and Thought Structures

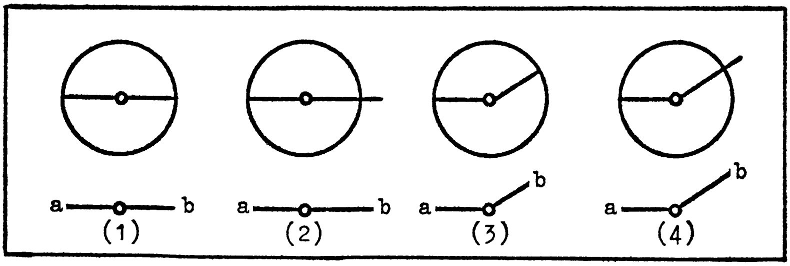
The genetic theory suggests the thesis that there is a "partial isomorphy" between perceptual schemata and the logical schemata of abstract thought (Piaget and Morf (285)).

Two structures are "isomorphic" when a structural correspondence holds between them. In other words, whenever there is a bilateral correspondence between the units of two structures then they are isomorphic. When equal in magnitude isomorphic structures will coincide (geometrical coincidence); and if unequal in magnitude, the relationship between them may be described as structural projection (geometrical projection).

Two structures may be said to be "partially isomorphic" when either of the following conditions holds: (i) When there is a bilateral correspondence between some and not all of the units of the two structures. (ii) When, given a complete bilateral correspondence, one structure is a fainter copy of the other structure. It is one or both of these types of partial isomorphy that is held to exist between perceptual structures and the logical structures of abstract thought.

The partial isomorphy between perceptual structures and logical structures may be briefly described in the case of three basic concepts: class, relation, inference (cf. Chapter 2). To begin with the concept of class, we have seen that the "logical class" is not identical with the aggregate of its members. Yet a "perceptual class" is, in contrast, nothing but an aggregate of units with a common trait. And the isomorphy between these two types of classes is only partial. Piaget calls the perceptual class an "infraclass," indicating its concrete nature in contrast to the abstract nature of the logical class. What is said about the class also holds about the concept of relation; for a partial isomorphy appears to hold between the logic of relations and the system of "infrarelations" operating in perception. As for inference, while logical inferences are always analytic and necessary, the inferences involved in perception lack analyticity and necessity. Yet, like logical inferences, they involve a synthesis of the premises. The perceptual elements correspond to the logical premises; and the grouping of these elements to the logical conclusion. Thus there exists such a thing as a perceptual inference which may better be called "perceptual preinference" since it is still a far cry from the logical inference. This partial isomorphy between perception and logical thinking, however, should not overshadow their fundamental and great differences. Logical inference is carried out within the framework of logical laws; perceptual preinferences take place within the framework of rudimentary perceptual schemata. In the logical inference the subject deduces a new element (conclusion) from a set of elements (premises), and he is conscious of both the analytic relationship between them and the necessity of the deduction. But in perception when the subject is faced with a set of perceptual elements he may perceive them and nothing more; and after another element has been added to the set, he often becomes conscious of an additional new element which could not have been perceived on the basis of the first set alone. It may be noted that the "perceptual preinference" of the genetic theory corresponds to the "perceptual decision" of the set theory.

The whole point of the laborious research undertaken in this area has been to demonstrate a "partial isomorphy" between perceptual structures and the logical structures of abstract thinking. And if the hypothesis of partial isomorphy be true, then perceptual structures should undergo, analogous to logical structures, a genetic evolution. A few experiments have been performed to verify this conclusion (84–VI). As the most representative of these, we shall briefly describe the experiment performed by Morf (84–VI: p. 120f):



(From: Études d'épistémologie génétique, 6 (1958), p. 120 f.)

A set of figures were presented, first the segments alone and then the segments with the circles, in random order. The shorter segments were 10 centimeters long; and the longer segments were longer by 10%; between them they formed an angle of 135 degrees. Twenty subjects were classified into three age-groups: 4–5, 6–7, and 8–9 years. Their task was to express their judgments about the comparative lengths of the segments. The responses revealed three stages of perceptual development corresponding to the three age-levels. The judgments of the first group about the first element (segments) did not in any way profit from the addition of the second element (circles), but persisted despite this fact. The second group utilized the reference circles, and perceived the length proportions to a greater extent, except for the comparison of the horizontal segment with the diagonal segment. The responses of the third group showed considerable improvement relative to those of the second group, for they perceived the circles as "good forms," containing the segments and representing their geometrical proportions. Thus perceptual preinferences were shown to be subject to evolution, as a function of age-level, analogous to the development of the logical inference.

It must be noted that the hypothesis of partial isomorphy implies only an *affinity* between perceptual and thought processes. And the affinity between perception and thinking, whatever of it there may be, must be kept *separate* from the problem of the *genetic priority* of one to the other. For structural affinity between two events does not establish the priority of either one. It is to the problem of priority therefore that we shall now turn.

3. *Is Perception Genetically Prior to Thinking?*

The accurate answer to this problem would be to say both yes *and* no. *Yes*, in the sense that obviously perceptual activity commences at a far earlier genetic stage than the operations of thought. Thus, in its *genetic order*, perception is prior to thinking. *No*, in the sense that, although perception precedes thinking in time, the abstract operations of thought (concepts) are not generated by perception as such.

We have seen that despite the affinity between perceptual structures and logical structures there are fundamental differences between them. For example, the "logical class" is an intensional concept in which class-membership is a purely morphological relation; while the "perceptual class" is an extensional concept in which class-membership is a spatial affair, such as the partitive relation between an aggregate and its units. The same holds true for the concept of relation. Perceptual structures do not possess the generality which logical structures possess. Consequently, perception *per se* is not able to yield logical structures, that is, structures whose properties extend beyond the data of perception. Piaget and Inhelder (284), having investigated the genesis of elementary logical structures in a series of closely related experiments, specifically concerned with the operations of "classification" and "seriation," arrived at the result that, because of the essential difference bebetween perceptual and logical structures, not perception alone but perception *together* with the autonomic coordinations of the subject might explain the ontogeny of the elementary logical operations. At the more advanced genetic levels, of course, the formation of complex logical structures may be explained with reference to the process of "constructive abstraction." Thus, although perception genetically precedes logical thinking, and although there exists a partial isomorphy between the perceptual and logical structures, nevertheless logical operations are not generated by perception as such. For, while perceptual experience may constitute a necessary condition for the operations of thought, the former is by no means the sufficient condition of the latter. Consequently, any form of crude empiricism (e.g. the sensationist theory of perception), which attempts to derive all conceptual knowledge from perceptual experience, is not to be maintained on psychological grounds.

Leaving the problem of the relationship between perception and thinking, for the time being, we shall turn to the perceptual processes themselves, and examine their nature from the standpoint of the genetic theory.

4. *Perception as Assimilation*

It may be recalled that when the set theory described perception as categorization, the genetic theory raised the problem of the *origin* of the "categories" of perception. The hypothesis suggested by the genetic theory (Piaget (266)) is that the genesis of these categories lies in the autonomic activities of the subject. The two phases of these primitive perceptual activities are: (i) *Differentiation*—by which the border-line between the figure and the ground is traced. (ii) *Integration*—by which a set of discrete elements is perceived as a figure. These two processes are coordinating processes; and, after a series of cyclic repetitions, give rise to a set of acquired assimilatory schemata. Once formed, the elementary assimilatory schemata begin their own evolution in a two-fold way: First, by their internal structuration and differentiation as a function of time; second, by the external influences of perceptual experiences, even though these experiences themselves are partially determined by the schemata.

The three conditions of assimilation as they are formulated by Piaget (276) are:

(i) The existence of psychological schemata.

(ii) The alteration of the object of perception by the schemata of the subject.

(iii) The operation of perceptual preinference or logical inference in the veridical perception of the object.

All of these conditions exist in the perceptual process. We have seen the role of perceptual preinference in veridical perception. The assimilatory schemata of perception are anterior structures which constitute the structural determinants of perception. They may be considered to be the genetic aspect of the *set*. And the role of the set in perception is stressed by the genetic theory (Piaget (276)). Accordingly this theory describes perception as *assimilation*; and suggests that we do not simply experience phenomena but rather "read-off experience." The "reading-off of experience" (*lecture de l'expérience*) is a function of the subject's set, which in turn is determined by his psychogenetic level. The "principle of equilibrium" regulates the direction of psychogenetic evolution: All psychological structures tend to achieve good form and stability.

Two experiments illustrate the assimilatory nature of perception: In an experiment by André Rey (Piaget (266)), a group of children (ages 4–6) were presented with a sheet of paper (10 $\times$ 10 centimeters) on which was drawn a standard square (e.g. 4 $\times$ 4 centimeters). The subjects were asked to draw with pencil the smallest and the largest possible squares on the sheet. They at first drew squares barely smaller and barely larger than the standard; then they proceeded by successive attempts to make the small square smaller and the large larger. Their method of procedure was that of trial-and-error and at no point indicated an anticipation of the results. In contrast an older group of children (above the 7-year age-level), as well as adults, were able to draw the smallest square (1–2 millimeters) and the largest square (along the edge of the 10-centimeter sheet) with their very first attempt. These results indicate two things: First, that it is because of their lack of comprehension concerning the abstract groupings of asymmetrical relations (e.g. $A > B > C$) that children fail to solve this type of perceptual problem. Thus they fail, in their imagination, to go from the barely small to the smallest and from the barely large to the largest *before* proceeding to action. Second, that consequently logical operations are one of the determinants in the assimilatory process of perception.

In another experiment Beizmann (29) presented some Rorschach figures to 300 Parisian school children (ages 3–10 years). It was a typical Rorschach test in which the subjects were asked to describe what they saw in those figures. Three types of perceptual responses were noted: (i) Figural perceptions into which subjective emotions and feelings were projected—e.g. the figures appeared fearful, edible, nauseating, etc. (ii) Figural perceptions which were colored by superstitious beliefs—e.g. the subjects saw monstrous bats etc. (iii) Figural perceptions which reflected the natural knowledge of the subject derived from experience—e.g. the figures were seen as trees, clouds, rocks, leaves, etc. These results indicate that cognitive as well as emotive factors are determining factors in perception. Indeed the main theoretical import of the whole series of Rorschach phenomena is that perceptual projection is a function of the subject's emotive *and* cognitive set.

5. Hypothesis of Centrations

The genetic theory distinguishes two types of perception (Piaget (273)): (i) "Primary perception" which is the perception of an object as it is given in the first centration of attention. It may be, and often is, a deformed perception. (ii) "Secondary perception" which is the perception of an object resulting from a series of comparative centrations. The latter is to be distinguished from the classic concept of "apperception" which is the *awareness of* perception, in this case, of secondary perception. The distinction between primary and secondary perceptions is the starting-point of the hypothesis of centrations formulated by Piaget (266) (273). According to this hypothesis the perceptual *centration* generates a perceptual deformation—"centration" being defined as the unification of various elements in perception (e.g. visual fixation). The main feature of this deformation consists of an overestimation of the central elements and an underestimation of the peripheral elements in the field of perception. For there is a maximum degree of perceptual assimilation at the center of the object, and a minimum degree of assimilation at its periphery. The *decentration* has a regulatory effect, reducing the maximum and increasing the minimum by successive *recentrations*, and resulting in a more veridical perception. A theoretical model could be constructed, employing the theory of probability, to describe the degree of this perceptual regulation as a function of successive centrations. For this purpose the concept of *encountering*, which is the quantifiable counterpart of the qualitative concept of centration, may be used. An "encoutering" (*rencontre*) may be defined as a point of correspondence between the percept and the object. Thus in the case of the optical illusion there is a "partial encountering" of the corresponding set of points between the object and the percept; and in the case of the veridical perception there is a "complete encountering" (*couplage*). The concept of "complete encountering" is the psychological counterpart of the concept of "geometrical projection." Of course there will never be a "complete encountering" between the percept and the object. For the same reasons, which have rendered the representative theory of perception untenable, operate here: Namely, the percept is a function of the object *and* the subject. This concept then may be simply considered as a part of a theoretical model which illustrates the applicability of the calculus of probability to the genetic theory of perception. Thus if the aggregate of possible encounterings be represented by $\mathcal{N}$, and the number of actual encounterings (proportional to the number of centrations) be represented by n, then the number of the remaining unencountered elements will be equivalent to (N — n). Let this remainder be $\mathcal{N}_1$, then the successive centration will result in the encountering of only a part of it, n_1, and the formula would repeat itself. The net result of these repetitions will be a logarithmic function corresponding to the empirical curves. Thus the hypothesis of centrations is susceptible of a statistical representation.

The most noteworthy consequence of the hypothesis of centrations is the "law of relative centration" (Piaget (266)). We have seen that the degree of figural illusion is proportional to the aggregate of actual centrations. The law of relative centration may be stated as follows: The relative distortion of a perceptual figure is equivalent to the ratio of the number of possible centrations to the number of actual centrations.

That is:

$$\text{Perceptual Illusion} = \text{Aggregate of Possible Centrations} : \text{Aggregate of Actual Centrations}$$

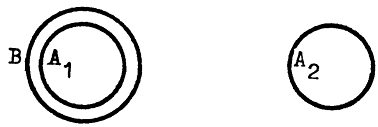
The law of relative centration is complementary to Weber's classic law:

$$\frac{\Delta I}{I} = K$$

Which states that the intensity of a stimulus (I) must be increased by a constant fraction (K) of its own value ($\triangle$I) to approach the threshold of noticeable difference. Thus the greater the dimension of the stimulus, the higher the threshold for its noticeable difference. The weight of an ounce added to another ounce will be perceived far more readily than that of an ounce added to a hundred ounces; and in the silence of the laboratory the sound of a second decibel added to the first has a pronounced effect, but a child shouting at the top of his voice (80 decibels) in the frenetic traffic of a modern city (95 decibels) will hardly be heard. The point is that Weber's law states that every objective difference is subjectively distorted; and the law of relative centration, that the subjective distortion of the objective difference is a function of centrations.

Three representative experiments, which have confirmed the main implications of the hypothesis of centrations, will be described:

The first experiment, which was the first of a series of experiments on visual perception, was done by Piaget and Coworkers (279). The problem to be investigated was: What will be the perceptual effects of the systematic variation of the constitution of a perceptual figure? The figure used was the optical illusion created by two concentric circles relative to a third circle (the Delboeuf illusion). The subjects consisted of 100 Genevese school children of four age-groups (5–6, 7–8, 8–9, 10–12 years) and 30 adults. Their task was to estimate the relative sizes of the circles, and their responses were recorded as a function of the variation of the figure and the repetition of centration.



The illusion of the concentric circles.

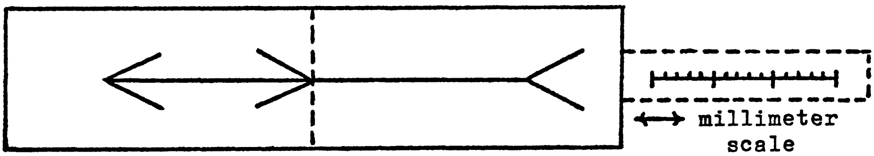
If a circle A_1 (radius = 12 millimeters) be drawn within another circle B (radius = 15 millimeters) then it appears to be larger than an isolated circle A_2 equal to A_1. This describes the positive phase of the illusion. By varying the size of the external circle B in both directions, increasing or decreasing, the positive illusion tends to be reduced. A little beyond the point of doubling the size of the circle B (when the B radius = 36 millimeters), the positive illusion approaches zero, and the circles A_1 and A_2 appear to be equal. But the enlargement of the size of the circle B beyond this point will generate the negative phase of the illusion, in which the size of the inner circle A_1 will be underestimated relative to the outer circle A_2.

As a result of this experiment it was realized that the magnitude of the illusion was inversely proportional to the age of the subject. Thus children had greater illusions than adults; and the suggested explanation for this difference was the inability of children to achieve perceptual decentration with as much facility as the adults. And the reason for this is in turn, as we shall see, the perceptual "strategies" used by children. Five generalizations were made on the basis of this experiment: (i) Perceptual illusion is a function of: (a) the structural dimensions of the perceptual object; (b) the psychogenetic level of the subject. (ii) The central area of the perceptual field is overestimated relative to the peripheral area which is underestimated. (iii) The degree of the underestimation of the peripheral zone is a function of its distance from the point of centration. (iv) The successive centrations are compensatory provided they are not coincident; for they result in perceptual decentration in which new elements are brought into attention. Hence the degree of the illusion is inversely related to the frequency of various centrations and the distances between their points of fixation. Decentration is achieved by a shifting of the central-peripheral areas, which may result either from recentration or from restructuring of the figure (e.g. enlargement of the external circle, in the illusion of the concentric circles, causes the central area to shift from the inside of the internal circle to the outside of its circumference, resulting in the negative phase of the illusion). (v) The frequency of centrations being constant, the degree of decentration is a function of the structural properties of the object. Thus some illusions are more persistent in the face of inspection than others.

The second experiment was performed by Vinh-Bang (84: XIII–XIV). The problem was to investigate what the child perceives of a composite figure in very short intervals of time. A set of composite figures (e.g. circle with straight lines intersecting; triangle and a curve superimposed; etc.) were presented in the tachistoscope for the durations of 0.02 to 0.10 seconds. The subjects (ages 5–6 years) were instructed to reproduce the figures with flexible colored wires placed on the table before them. The results were: (i) The time threshold for the perception of visual patterns was higher for children than for adults. (ii) The perception of the composite figure was a function of its complexity: Two-element figures were perceived and reproduced exactly; in the three-element figure the third element was often omitted; in a composite figure with more than three elements only the most prominent two or three elements were perceived and reproduced. (iii) Repetition of the tachistoscopic presentations resulted, through a very gradual process, in the complete perception of the composite figures (1–3 elements). (vi) When two simple figures were presented separately first, and afterwards superimposed to form a composite figure, the subject still saw the composite figure as *two* figures superimposed; but when the composite figure, whose elements were two simple figures, was presented first, it was seen as *one* figure. These phenomena are explanable in terms of the hypothesis of centrations.

It follows from the hypothesis of centrations that the successive perceptions of the same object are different—up to the point of decentration and stabilization. We have seen that successive perceptions affect the preceding ones, and that a series of centrations terminate in a decentration. It would be interesting further to know the patterns of these perceptual changes. This problem may be studied experimentally by presenting the same object to the subject a great number of times, and measuring the subtle variations of the perceptual series. The optical illusions provide particularly good material for the investigation of the variations of perception; for illusions are generally "bad figures," and perceptual variations are far more pronounced in their case than in the case of the "good figures." This brings us to the third experiment to be described.

In an experiment using the Mueller-Lyer illusion, Noelting (239) studied the patterns of perceptual variations as follows:



(The Mueller-Lyer illusion)

The Mueller-Lyer illusion was drawn on an opaque ruler which consisted of two sliding pieces. On one piece was drawn a straight line (70 millimeters) with closed arrow-wings (20 millimeters) at 30 degrees angle with the straight line. This line continued onto the other piece, ending with open arrow-wings of the same measure, with a maximum length of 45 millimeters. When the sliding ruler was fully drawn out it produced an illusion of 25 millimeters in length. On the reverse side of the ruler there was a millimetric scale which permitted the experimenter to read off the magnitude of the illusion as the difference between the subjecive point of adjustment and the objective point of equality. The method of adjustment was used. The subject was seated before a table on which the figure with the full illusion was placed about 30 centimeters from his forehead. He was instructed that the lengths of the straight lines were variable, and that he should adjust them carefully till they appeared to be equal. This done, the experimenter took the ruler, read and recorded the illusion, promptly drew it full length again, and handed it back to the subject with the same instructions. The subject was never informed that there was an illusion to be corrected—but rather that it was a task at precision adjustment. 125 subjects were divided into six age-groups (5, 6, 7, 8, 9–10 years, and adults) with roughly 20 subjects in each group. The successive values of the illusion were read off for the first 20 trials for each subject, and marked on a graph as a function of trials. A curve of individual practice was obtained with a definite range of variability. Although the dispersion of the trials was not haphazard, the individual curves did display fluctuations. And to determine the basic tendency behind these individual fluctuations the following technique was used: For every age-group the values of the illusion for each trial were added, the mean was taken, and a general group curve constructed. The method of regression permitted the fitting of a theoretical curve over the actual performance curve; thus the fluctuations of the latter were considered as deviations from the central tendency represented by the regression curve. For this purpose an exponential regression curve of the second degree was sufficient, since of the three phenomena of the illusion (rise, fall, constancy) only two appeared in a given group. (A third degree curve would be necessary if all three phenomena appeared in any group). The linear equation for this curve is: $y = ax + K$, where $y =$ value of illusion and $x =$ subjective trial. With reference to this curve the individual tendencies of the subjects were judged as "significant." The criterion for the significance of tendency was the limit of deviation of the individual curves from the regression curve coefficient—any deviation exceeding 10 percent being considered as insignificant. The quantitative results were: 30 percent of the subjects showed no significant tendency; 70 percent showed significant tendency. And the three types of tendencies in the latter corresponded to the three phenomena of illusion: (i) The illusion increased at first, instead of decreased, in the youngest age-group (5–6 years). (ii) The illusion decreased at the older age levels (above 7 years). (iii) A plateau was reached at the end of the illusion curve which indicated the termination of the fall. These phenomena were explained with reference to two effects: (i) The genetic effect (anterior structures corresponding to the age level). (ii) The practice effect (recentration which regulates centration and decentration). Both these effects, having the same direction, are convergent effects. The initial increase of the illusion was explained by the fact that the time threshold for perception is higher at the lower genetic levels. Thus children—in taking their time in the transition of a partial perception to a complete perception of the figure (trials 1–4)—perceived the full magnitude of the illusion gradually. The whole process of perceptual variation then may be described, from the genetic standpoint, as a process of "progressive enregistering" (*enregistrement progressif*) and "regulatory centration" (*centration régulatrice*).

It may be remarked that, despite the hypothesis of centrations, perception is not, from the genetic standpoint, a statistical affair whose only regulatory laws are probabilistic laws. The hypothesis of centrations is only a part of the genetic theory of perception; and the theory as a whole, as we have seen, is far from being statistical.

6. *Hypothesis of Strategies*

The hypothesis of perceptual strategies is a conceptual model which corresponds to the probabilistic processes of perceptual centrations. It consists of the description of four perceptual strategies which the subject adopts in genetic order:

(1) The first strategy consists of centering upon only one of the two elements in the field of perception, A and B, and seeing this element (A) as a deformed element (A′).

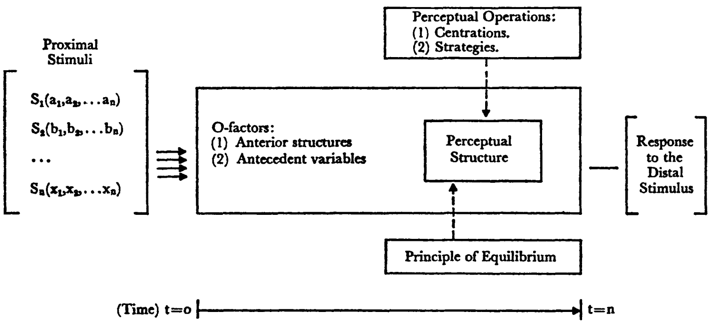
(2) The second strategy consists of centering upon the other of the two elements (B) and seeing it as a deformed element (B′).

(3) The third strategy consists of centering upon A and B alternatively, with alternate overestimations and underestimations of each relative to the other, but with a progressive process of decentration.

(4) The fourth strategy consists of the subject's perception of the fluctuations of his perception during the third strategy, and of the final propensity to settle upon a midpoint between the extremities and see them with the least degree of deformity.

It would appear that the concept of "strategies" constitutes the last psychological bond between the processes of perception and thinking. However, it may be observed that "strategies," if they operate in perception, must be fundamentally different from the hypothetical strategies of thought processes. For this concept, in the context of the psychology of thought processes, refers to an underlying process of hypothetical judgment. Indeed, the concept of "strategies," as an importation from the context of American psychology (notably Bruner & Coworkers (48)), remains a nascent conception in the context of the genetic theory (cf. Piaget (273)). And it is to be feared that the application of this concept in the description of perception, which after all has little to do with hypothetical reasoning, would prove misleading. And, in view of the partial isomorphy between the operations of perception and thinking, it would be more correct and consistent for the genetic theory to speak of "perceptual prestrategies" similar to the "perceptual preinferences." However, the concept of "structure," with its various ramifications, would be logically sufficient to explain the same facts with greater consistency within the genetic theory. For, in the final analysis, the family resemblance between the genetic theory and the gestalt theory rests upon their conceptual continuity. With respect to this the reader might comparatively examine the schematic representation of the two theories.

At the conclusion of our examination of the genetic theory of perception reference might be made to the relationship between this theory and the gestalt theory, to the supplementary contribution of this theory to the revolution in the psychology of perception, and to the epistemological implications of this psychological theory. These points have been already elucidated with sufficient detail in the conclusion of our examination of the gestalt theory of perception. As for the concept of "structure," which plays a fundamental role in the psychology of perception, it will be examined from the epistemological standpoint later (cf. Chapter 7).



(Genetic Schema of Perception)

CHAPTER 4

PHENOMENA OF GENETIC PSYCHOLOGY
(School of Geneva)

The theoretical scope of European genetic psychology, especially the French Phase, is reflected in the complex range of its experimental studies. We shall describe by the general term "genetic cosmology" the whole class of the resulting psychogenetic phenomena which comprise the following areas of the cognition of the external world: (a) the conception of natural objects and events; (b) the conception of space and time; (c) the conception of the relations between things (especially physical causality); (d) the conception of the qualitative dimension (including logical forms) and of the quantitative dimension (including matter and number). The task assigned to this chapter, then, will be to outline the formation of these cosmological conceptions on the basis of the observations of experimental genetic psychology. Accordingly, we shall describe in the following pages only the most representative studies. For the completeness and detail, which characterize the work of this psychological school, as well as for numerous other experiments, the reader may be referred to the writings of Piaget and other psychologists of the French Phase (cf. General Bibliography).

The general objectives of these experimental studies, in the light of which the relevance of their multifarious specific objectives are to be evaluated, may be described as follows:

(1) The experimental observation and description of the ontogeny and transformations of the cosmological conceptions as a function of time.

(2) The experimental investigation of the forms of the operations of thought, which determine, in the final analysis, the nature of the cosmological conceptions in general.

The methodology of these experimental studies, consisting of the "psychogenetic method" and the "operational logic," have been described previously. The special experimental techniques, associated with the various experiments, will be described in their proper contexts. However, the general genetic theory of thought processes, which has been constructed on the basis of these experiments, will be reserved for another chapter.

I. CONCEPTION OF NATURE

The psychological problem, connected with the relativity of the conceptions of the external world, is derived from the fact that there exists a great gap between our conceptions and the conceptions of children: What is then the origin of this psychological gap, and how is it naturally closed as a function of age? The experimental observations of Piaget (256), concerning children's conceptions of natural objects and natural events, will be interesting to both psychologists and philosophers. Applying the psychogenetic method, the experimenter asked the subjects (ages 4–12 years) to explain: (a) The nature of a given natural phenomenon; and (b) the origin of the same. The results of this investigation for the various phenomena are the following:

(1) The explanations of the origins of the *stones* and the *earth* acquire three successive forms. First the subject explains that both are made by the disintegration of the houses built by men; second, that they are made from each other, by men, through the process of hardening the earth (e.g. cementing) and breaking up the stone, respectively; third that they are made from each other by natural processes (e.g. the sea waves grind the stones into earth).

(2) The explanation of the origin of *mountains* passes directly from the stage of artificialism to the stage of naturalism. The subject at first explains that mountains were made by God or by men out of stones; and at a later age that they naturally grew out of the earth.

(3) The conceptions of the origins of *lakes and rivers* follow a parallel development through three stages. In the first stage the subjects explain that the beds of lakes and rivers were cut by men and were subsequently filled with water by men (example: the Lake of Geneva was made in this fashion); in the second stage, that the beds of lakes and rivers were cut by men but that the water was supplied by the downpouring rains; in the third stage, that both the beds as well as the contents of lakes and rivers have had natural origins.

(4) The explanations of the origin of *rain* have their own stages of development. At first rain is conceived to be pouring out of the sieve of the sky made by God. Then it is explained with reference to the steam from the houses made by men. And finally a natural explanation of rain is given in terms of evaporation and condensation. It is to be noted that the conception of snow undergoes a similar development. At first snow is said to be made by God or man in the network of the sky; then snow is considered to be a spontaneous product of the sky; and finally, snow is identified with frosted rain.

(5) The conception of *clouds* evolves through three stages: First, the subjects describe the clouds as a solid substance made by God or man; second, the subjects explain that clouds are made of smoke from the chimneys of the houses, and reason that were there no houses built there would be no clouds; third, clouds are conceived to be steam or vapor. And the conception of lightning undergoes an evolution parallel to that of the clouds. Lightning is first conceived to be made by God or man; then, to be made by clouds or the sun which in turn are made by God or man; and finally, to be made by the interaction of the atmospheric elements.

(6) The child does not discern the distinction between the phenomena of astronomy and the phenomena of meteorology. He tends to explain the nature and origin of both these classes of phenomena with reference to the same elements. Thus the *sky*, during the first stage, is described to be made by God of a solid substance (like stone) in the form of an arch touching the horizon; during the second stage, to be the product of smoke rising from the earthly houses of men; and during the third stage, to be the resultant of air and cloud formations. The nature of the *sun* is usually described as fire. The explanation of the origin of the sun passes through three stages: At first the subjects state that the sun was made by God or by men out of fire. At a later age they state that it was naturally made from the smoke of the fire which in turn was made by man on the earth (or from the coal mines and volcanoes made by man). In the final stage the subjects give a naturalistic explanation in terms of the atmospheric elements.

(7) The conception of the *night and darkness* passes through four stages: First, the night is identified with the condition for sleep; second, the night is identified with a black cloud brought about by man; third, nignt is conceived to be the condition for the absence of the day; fourth, night is explained with reference to the disappearance of the sun behind the horizon.

(8) The explanations of the origin of *plants* (*trees*) pass through three stages of evolution: In the first stage the subjects typically state that trees are made by men; in the second, that they grow from seeds but that the seeds are manufactured by men; in the third, that the seeds come from the flowers which in turn grow on the trees.

(9) What are the gentic forms of the conception of *consciousness* itself? The subjects were asked specific questions about whether, under hypothetical conditions, animals and inanimate objects had feelings and awareness (Example: Would the table, if pricked, feel anything?). The

responses indicated four successive stages of the evolution of the conception of consciousness. In the first stage, awareness and feeling are attributed to every object under the sun. In the second stage, awareness and feeling are attributed only to those objects which are potentially capable of motion (Example: the sun and the bicycle have feelings, but the table and the brick do not). In the third stage a distinction is made between automatic motion (self-caused motion) and heteromatic motion (other-caused motion), and consciousness is attributed exclusively to the class of things capable of automatic motion (Example: bicycles are not conscious but birds are). In the fourth stage, the class of automatic movers is identified with the class of animals, and the quality of consciousness is restricted to animals. Thus the conception of consciousness evolves from a pervasive animism to a well-defined animalism.

(10) The conception of *dreams* and the *dream life* is transformed from a physicalist conception to a psychological conception, in the course of the psychological development of the subject. During the first stage, the contents of dreams are assigned both an external reality as well as an external origin. The subject looks at his dream as having come to him from the outside and troubled his sleep. In the second stage, the subject comes to realize the subjective origin of the dream life, but insists upon the objectification (externalization) of the dream content. In the final stage, the subject recognizes the subjective origin of the dream content as well as the interiorization of the dream life.

(11) The child's conception of *thinking* should be of particular interest to the genetic psychology of thinking. For the conception of thinking itself has a psychological history analogous to that of the dream. The subject begins with a physicalist (behavioristic) conception of thought and gradually arrives at a psychological conception of it. The subjects were asked to tell what was it that they *thought with* when they thought of the things they often thought of. Three stages were prominent in the development of the thinking of the subject about thought. In the first stage he explains that thinking is done with the "mouth" and, consequently, by means of physical "words." In the second stage, the subject recognizes that thinking is done in the "head," but conceives of it still as a physical thing or process. In the third stage, he realizes both the psychological origin and psychological nature of thought in contrast to physical things.

Conclusion

From the experimental observations sampled above Piaget (256) concludes that there are three fundamental perspectives which simultaneously shape the child's conception of natural phenomena:

(1) *Artificialism*—according to which all natural objects have had an artificial origin (e.g. made by man). Complete artificialism (corresponding to 4–7 age-level) develops into a mixture of artificialism and naturalism (corresponding to 7–9 age-level) and ultimately evolves into complete naturalism consisting of a purely naturalistic interpretation of natural phenomena (corresponding to 9–12 age-level).

(2) *Materialism* (often referred to by Piaget as "realism")—according to which all psychological phenomena (e.g. dreams and thoughts) are conceived to have a physical existence inside or outside the subject. This naive materialism ultimately evolves into the realization of the dichotomy between the subjectivity of psychic events and the objectivity of physical events.

(3) *Animism*—according to which all things have consciousness and are therefore capable of having feelings. This pervasive animism eventually evolves into the duality of the inanimate (physical objects) and the animate (biological organisms).

From the genetic standpoint, then, the early philosophy of the child is characterized by artificialism, materialism, and animism. Subsequently, and very gradually, this natural philosophy is transformed into the perspective of naturalism and critical realism. And so the following problem presents itself: *Why* are the original viewpoints of the child what they are, and *why* do they undergo a transformation at a later genetic level? The diagnosis of the etiology of these phenomena by Piaget (256) may be summarized as follows:

The child, as a biological organism, has a psychological system with the axis of egocentricity. Now *egocentrism* involves the absence of an awareness of the cognitive gap between the self and the world, between the subject and the object. And from this egocentricity evolve two propensities: (a) The indissociation of the subject's psychological state from the external world, and consequently, the introjection of the subject's thoughts and feelings into other objects. (b) The logical confusion between the subject's "image" of the object and the "object" itself; and the concomitant confusion between the "sign" and the "significate." Hence words are confused with ideas, and language is mistaken for the thought. It is clear then that the psychological egocentricity is the progenitor of the perspectives of animism, artificialism, and materialism.

Before leaving this topic, reference must be made to the experimental observations of Maria Nagy (235) (236) of Radcliffe College. For these studies fall within an area not investigated by the psychologists of the French Phase, namely the child's anatomical and physiological conceptions, and yet they partially corroborate the general conclusions of Piaget.

(1) Experiment concerning children's conception of bodily functions. The three categories of functions studied were: (i) Functions of the nervous system (brain); (ii) Functions of the respiratory system (lungs); (iii) Functions of the digestive system (stomach). The subjects consisted of 650 Hungarian and American children (ages 4–12 years). They were required to describe the structure and functions of the three bodily organs, by means of essays, drawings, and interviews. The results indicated that children tended to entertain a *monolithic conception* of the structure of bodily organs: (i) The interior of the body is conceived to be identical in structure and texture to the exterior or the body. (ii) The internal bodily organs are thought to be made up of the same stuff (bone, flesh, blood). But this conception of the homogeneity of the structure of bodily organs was incompatible with the heterogeneity of their functions. That children were not too upset by this contradiction is to be explained with reference to the gradual evolution of their logical thinking.

(2) Experiment concerning children's conception of death. The subjects were 378 Hungarian children (ages 3–10 years). They were instructed to write all that they knew and thought about death, supplemented with drawings, and this was followed by an elucidatory dialogue between the experimenter and the subject. The results indicated three genetic stages for the conception of death: (i) In the first stage (ages 3–5 years) the natural animism of the child was extended to the concept of death itself. Not only inanimate objects were endowed with life, but also the absolute reality of death in living things was denied. Death was interpreted as a departure from this life, this world, into another existence. Thus death was regarded as a temporary episode relative to a given form of life. (ii) In the second stage (ages 5–9 years) an artificialism was inaugurated in which death was personified into a "Death-Man" whose evil doing is death. Thus the artificial Death-Man artifices death. And the nature of death was colored with the particular fantasies and fears of the subject. The universality of the death phenomenon was still not recognized; and the explanation for it was lacking. (iii) In the third stage (ages 9–10 years), concomitant with the development of

the child's critical realism, it was realized that death was a natural process which resulted in the dissolution of bodily functions. The universality and causal nature of death were recognized, and a more objective perspective was adopted toward it.

The experimental studies of European genetic psychology concerning the conception of natural phenomena, as well as various other experiments to be discussed in this chapter, give rise to a serious methodological problem: The problem of the relationship between the history of the subject and his conceptual framework. This problem will be fully discussed at the end of this chapter under the *Conclusion.*

II. CONCEPTION OF SPACE

Two aspects of our knowledge of space may be distinguished: (1) The *perception* of space which is involved in the identification and discrimination of objects in space. (2) The *conception* of space which is involved in the classification and reproduction of objects in space.

The problem of the relationship between the perception and conception of space is this: Does the perception of space directly give rise to the conception of space?

From the standpoint of genetic psychology (cf. Piaget and Inhelder (283)), the conception of space does not develop directly out of the perception of space. For the perception of space is not the sufficient condition for the development of the conception of space. The visual perception, for example, which will identify and compare objects in space, falls short of classifying them into categories. Categorization requires that the subject must have a concept on the basis of which to categorize. The attainment of concepts is a process of construction which utilizes a set of operations in addition to the data of perception. Operations, as we know, are logical structures. These logical structures intervene between perception and conception. And since perception itself is never completely independent of the conceptual framework of the subject, conception cannot be purely a product of perception. And haptic perception is in this respect no more exceptional than the visual perception. The case of the blind sculptor, which is the example *par excellence* of haptic perception, simply indicates the affinity of perceptions—in which the hand (haptic perception) prepares the form for the eye (visual perception). And this affinity of perceptions reflects, if anything, a unity of consciousness (cf. Von Hornbostel's theory of the unity of the senses).

It may be pointed out that here European genetic psychology once again declines from following the path of classical empirical philosophy (Locke and Hume)—which argued that perception is the sufficient condition of conception—and takes sides with the transcendental philosophy (Kant). The difference between transcendental philosophy and genetic psychology lies, of course, in that the former has absolute conceptions and the latter relative conceptions. The conceptions of genetic psychology are relative to the genetic level of the subject.

In an experiment on the conception of pictorial space (shape) Piaget and Inhelder (283) observed that children who had a perfect perception of simple geometrical figures displayed no conception of them whatever. The children were capable of perceptually identifying and comparing the figures; but they could not classify or reconstruct them until a later genetic stage. The subjects (ages 2–7 years) were asked to copy a set of simple geometrical figures which were drawn by the experimenter: triangles, circles, rectangles, circle-triangle configurations, circle-circle configurations, ellipses, etc. The results indicated four stage of development. Stage 0 (ages 2–3 years): The subjects produced pointless scrawls. Stage 1 (ages 3–4 years): The subjects progressed from advanced scrawls (open and closed scrawls corresponding to open and closed figures) to topological drawings which completely ignored the euclidean aspects of the figures. Stage 2 (ages 4–6½ years): The subjects began with a differentiation of the topological and euclidean aspects and ended up with a differentiation of the dimensions within the euclidean aspect. Thus their drawings distinguished straight figures (e.g. triangles) from curbed figures (e.g. circles) as well as straight figures with different numbers of sides (e.g. triangle and square). Stage 3 (ages 6½–7 years): The subjects were at last able to draw the geometrical figures correctly, representing both their topological and euclidean aspects, together with their angles and dimensions. This experiment indicates that the perception of an object is not sufficient for its conception; and that the attainment of an advanced genetic level, corresponding to the formation of a conceptual framework, is necessary for the attainment of concepts.

Two other studies support the thesis of the interdependence of the conception of pictorial space and of the formation of a conceptual framework. Helga Eng (83), of the University of Oslo, who made an intensive study of the genetic morphology of children's drawings, has noted a parallelism between the evolution of drawings and the evolution of abstract thinking. And the American genetic psychologist, Florence

Goodenough (112), has gone so far as to construct a scale for the measurement of children's intelligence on the basis of their drawings.

We have stated the relationship between the perception and conception of space. Let us now briefly review the genetic evolution of the conception of space.

From the standpoint of genetic psychology three aspects of space are to be distinguished (Piaget and Inhelder (283)): (1) the *topological aspect*; (2) the *projective aspect*; (3) the *euclidean aspect*. (As for the configurations of non-euclidean geometry, they may be regarded as a theoretical reconstruction of the configurations of topological, projective, and euclidean geometries). Let us consider the essential traits of these three aspects of space.

The essence of topological configurations is represented by the concept of *continuity*. Hence the geometrical elasticity of topological space, in contrast to the relative rigidity of projective space and the absolute rigidity of euclidean space. The essential concept of projective space is that of *perspective*—which presupposes, in addition to the elementary topological concepts, a view-point for the subject. Euclidean space, by precluding the subject and his perspective from the geometrical context, attains a *constancy* which projective space, despite its high degree of regularity, lacks. The configurations of euclidean space are not only constant (unlike projective configurations) but also well defined within the context of a constant set of reference coordinates (unlike the topological units). The absolute rigidity of euclidean space is the resultant of its objectivity, which won for it, from Kant, the adjective *a priori*. (It may be noted here in defence of Kant—whose theory of space has been criticized by some contemporary philosophers with reference to non-euclidean geometries—that when he called euclidean geometry *a priori* he was speaking of the *perception* of space and not of the *conception* of space. Non-euclidean geometries are conceptual reconstructions). The elasticity of topological space—(as is clearly demonstrated in Lewin's topological psychology)—renders it geometrically primitive. What is geometrically primitive, it will be seen, is also psychologically primitive—just as, as it will be seen in the case of the formation of the concepts of arithmetic, what was logically primitive was also psychologically, primitive. The important point to note here is the fundamental place of the three concepts of continuity, perspective, and constancy in the three spaces respectively. For it is by means of these three concepts that the genetic evolution of the conception of space takes place.

The phenomena of the genetic evolution of the conception of space, observed in representative experiments, will be briefly described in the following.

(1) Experiments on the conception of topological space. The idea of continuity is the synthesis of the topological conceptions. For all topological figures are characterized by the continuity of their contours. It follows that the conception of topological space must genetically precede the formation of the conception of continuity. Piaget and Inhelder (283) attempted to verify this hypothesis by an experiment and their results were positive: Long after the children had formed a conception of topological space they began to form the idea of spatial continuity. Another variation of the same experiment, however, has been performed by Morf (84: XIII–XIV), of the University of Geneva, with more precise results. And this experiment will be briefly described here.

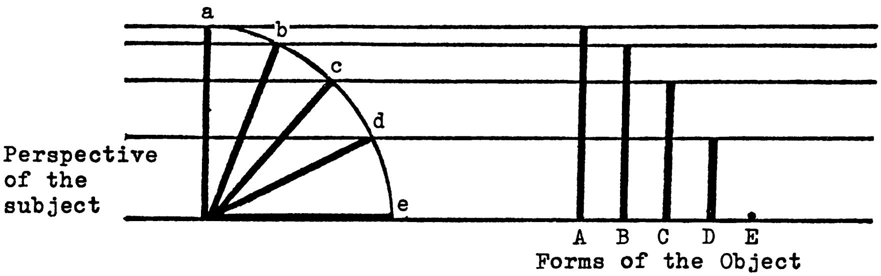
The concept of continuity, viewed from a psychological standpoint, leads to the concept of infinity. Hence the experiment to be described is about both the continuity and the infinity of space. The material consisted of a set of sticks with the lengths of 1, $\frac{1}{2}$, $\frac{1}{4}$, 1/8,... units. They represented a convergent geometrical series: $1 + \frac{1}{2} + \frac{1}{4} + 1/8 + \ldots$ Two problems were presented to the subjects (ages 9–16 years): (a) Can the additive series of sticks be continued indefinitely or will it terminate at some point? (b) Taking two full-length sticks we will have: $1 + 1 =$ 2 units. If we leave the first unit there and divide the second unit into successive halves we will have: $1 + \frac{1}{2} + \frac{1}{4} + 1/8 + \ldots$ The problem is: (a) Could the subdivisions of the remaining "half" into two "halves" be continued indefinitely? (b) Would the ultimate sum of the series obtained by subdivision be equivalent to 2 units, or would it be less or more than 2 units? The results indicated three stages of development. Stage 1: The subjects (ages 9–10 years) considered both the additive and the divisive geometrical series to approach a strict limit (when the elements become too small to be divided or added up any further), yet they thought that the sum of the series would exceed the number 2. Stage 2: The subjects (ages 10–12 years) considered the additive series to be unlimited; and the divisive series, always being less than or equal to the number 2, to have a perpetual continuation. Thus the answers of the subjects of this stage were often contradictory (the contradiction between the divisive series equalling the number 2 and yet continuing its divisions indefinitely). Stage 3: The subjects (ages 12–16 years) gave affirmative and coherent answers to both problems indicating their basic comprehension of the continuity and infinity of space.

(2) Experiments on the conception of projective space. The conception

of projective space, viewed from the psychological standpoint, involves the coordination of various perspectives in space. Therefore the psychological study of projective space might well begin with the study of configurations viewed from different perspectives. Two experiments, both performed by Piaget and Inhelder (283), will be briefly described in the following. One experiment will study the development of direct perspective (perspective of the object); and the other, the development of indirect perspective (perspective of the shadow of the object).

Experiment I (Conception of Direct Perspective):

The subjects (ages 4–9 years) were presented with the following problem: They were shown an object (e.g. a pencil) and asked to imagine its apparent shapes when placed in a number of different positions.



(From J. Piaget & B. Inhelder: Child's Conception of Space. Routledge & Kegan Paul Ltd., London, 1956.)

The response of the subjects indicated three stages of development. Stage 1: The subjects (below 4 years) gave no significant responses. Stage 2: The drawings of the subjects (ages 4–7 years) displayed a partial or complete failure to distinguish the different perspectives from which the object was viewed. Stage 3: The subjects (ages 7–9 years) distinguished the different perspectives clearly, first in their qualitative aspect, and later in their quantitative aspect.

Experiment II (Conception of Indirect Perspective):

The apparatus consisted of a set of geometrical objects (e.g. rectangles, circles, cones), fixed upon a firm wire-stand, placed between a lamp and a vertical white screen. These three items were separated by only a few centimeters. The subjects (ages 4–9 years) were asked to either draw the expected shape of the shadow of the geometrical object or to choose the expected shape from a set of sample drawings. The responses indicated three stages. Stage 1: The subjects (ages 4–6½ years) simply drew the shape of the object, from the standpoint of their perspective, regardless of the perspective of the lamp. Stage 2: The subjects (ages 7–9 years) drew the shape of the shadow correctly, from the perspective of the lamp, at first in its qualitative aspect alone and later in its quantitative aspect. Stage 3: The subjects (above 9 years) drew correctly the more complex geometrical figures from the standpoint of the indirect perspective.

(3) Experiments on the conception of euclidean space. Two fundamental conceptions which are basic to euclidean space are: (a) The conception of geometrical isomorphism which consists of geometrical similarity and geometrical proportionality. (b) The conception of geometrical coordinates which constitute the frame of reference for geometrical structures and their interrelationships (analytic geometry). The genetic formation of these two conceptions were investigated in a pair of experiments by Piaget and Inhelder (283).

Experiment I (Conception of Geometrical Isomorphism):

The subjects (ages 4–10 years) were presented with a pair of problems involving the similarity and proportionality of geometrical figures (triangles): (a) They were asked to draw figures geometrically similar to given model triangles (equilateral, isosceles, scalene). (b) They were asked to classify a set of cardboard triangles (equilateral, isosceles, scalene) on the basis of their geometrical similarity. The results indicated three genetic stages. Stage 1: The subjects (ages 4–7½ years) drew the figures without paying attention to the equality of the angles or parallelism of the sides, and they classified the figures without any systematic checking of the coincidence of the figures. Stage 2: The subjects (ages 7½–9½ years) attempted a systematic comparison of the angles and sides of the triangles both in their drawings as well as in their classifications. Stage 3: The subjects (above 9½ years) achieved the concept of complete proportionality for all the dimensions involved, as indicated by their drawings and classifications.

Experiment II (Conception of Geometrical Coordinates):

The subjects (ages 4–10 years) were presented with the following pair of problems about horizontal and vertical coordinates respectively: (a) They were shown a pair of narrow-necked bottles, one with straight and one with curved sides, both filled about one-quarter full with a colored liquid. The subjects were to indicate the position that the liquid would assume when the bottles were tilted. For this purpose identical empty bottles as well as outline drawings of the bottles tilted at different angles were supplied. (b) They were requested to draw the diagram of a mountain with houses and trees upon it. The results indicated three stages of development for the conception of spatial coordinates. Stage 1: The subjects (ages 4–5 years) were not able to conceive of either the liquid or the mountain as a plane surface. Stage 2: The subjects (ages 5–7 years) did have a conception of plane surfaces but they did not coordinate them correctly (For instance, the liquid in the tilted bottle tilted in the wrong direction; and the trees on the mountain were perpendicular to the slope of the mountain). Stage 3: The subjects (ages 7–10 years) solved the problem correctly. They were able to predict the variation of the horizontal and perpendicular surfaces on the basis of their conception of the system of coordinates.

The genetic evolution of the three aspects of the conception of space, as revealed by these experiments, may be outlined as follows:

The concepts of topological space are formed first, of projective space next, and of euclidean space last. Shortly before the age of seven the child forms the concept of *continuity*—upon which rests the conception of topological space. But the child fails to comprehend the concepts of projective space as long as he has not transcended the adualism which prevails in the preoperational years (ages 4–6 years). For the comprehension of projective concepts presupposes the subject's awareness of the psychological boundary that separates him from the external world. This consciousness gives rise to the concept of *perspective* (viewpoint). At about the age of 7–8 years, the child, looking over the cleavage of a newly formed dualism (between the subject and the world), acquires a perspective, and begins to gain insight into the nature of projective structures. But still in the projective structures and their transformations —which are irreversible at the perceptual level and reversible at the operational level—the preservation of the geometrical elements remains, for the child, unexplained. The child arrives at this explanation by the learning of the concepts of euclidean space on the basis of the concept of *constancy*—which in turn presupposes the concept of reversibility which is not formed until after the age of 9–10 years.

After the study of the formation of the conception of space (Piaget and Inhelder (283)), Piaget and his coworkers (280) studied the formation of the conception of the measurement of space. We shall refrain from describing here the series of tiny "game experiments" which are for the most part variations upon the representative experiments which we have sampled above. But the general results of this research will be stated. There appear to be three main stages in the formation of the conception of geometrical measurement: (1) In the first stage (ages

5–6 years) the conception of the qualitative conservation of length is formed. (2) In the second stage (ages 7–8 years) the conception of the quantitative conservation of length is formed. (3) In the third stage (ages 9–10 years) the conception of the analytical coordination of spatial dimensions is formed. In general, the genetic stages in the formation of the conceptions of space and of spatial measurement correspond to each other. It may be noted here that studies made of the evolution of children's drawings, outside the School of Geneva, only partially support the above results concerning the psychogenesis of the conception of space. Specially significant are the studies of Helga Eng (83) of Oslo, which find a direct correlation between the forms of drawings and intelligence, but do not discern the three Piagetian stages. And the studies by F. Goodenough and L. Partridge, in America, confirm the same general conclusion.

III. CONCEPTION OF TIME

Two aspects of time may be distinguished:

First, the *serial aspect* which represents time in the form of a discrete series consisting of successive units. The measurement of serial time consists of the automatic markings of an iterative process in a "time machine."

Second, the *aspect of duration* in which the "stream of time" flows uninterrupted by the digits of any analytic framework. The perception of duration is a purely psychological event which attention, or the absence of attention, can deploringly shorten or agonizingly lengthen. It is a commonplace fact that in the halls of waiting we seem to wait forever; for, anxious to leave, we focus our full attention upon the duration of time. It is at such times that the past haunts our present more than ever. Under the focus of attention, duration expands into duration, and the images of the past resurrect from the tomb of memory. It is possible, of course, to "drown" the wave of duration by indulgence in an activity. But in that case the *duration* is not annihilated; rather the *consciousness of* the duration has been diverted. We must not forget, however, as William James (146–I) has pointed out, that the imagination of the past is a present imagination. To forget this would be to forget the present and relive the past. It would be *as if* time had flown backwards.

This brings us to the problem of whether time is in any sense a reversible process. Whatever the answer of the philosophy of physics may be to Margenau's famous question (220)—"Can time flow backwards?"—the psychologist's answer, unless he were to adopt a physicalist definition of time, must be both *yes* and *no*. Yes—in the sense that retrospection can reverse the course of duration; that imagination can revive the past; and that consciousness can excavate in the ruins of memory. And the past phenomenology experienced in this way is no less "real" than the events of our present dreams and present life. No—in the sense that the retrospection of the past is always a present retrospection; that the reversal of the direction of duration invariably begins and ends in the present; that the starting point for every complete backward flow of time is a point in present time; that once time has flown backwards it can never again flow backwards from the same point at the present time; and that every time time flows backwards it must flow from a later point of time than it had flown before. Thus the backward flow of time always takes place *within* the forward flow of time. And the train of duration, with all its reversals, appears to continuously move forward. But this double movement of duration will cease to be a contradiction as long as we abide by a purely psychological conception of time and refrain from any physicalist definition. Let us turn then to the psychological conception of time.

The story (cf. Piaget (275)) is that several years ago Professor Albert Einstein had come to Switzerland to preside over the conference of the International Congress for the Philosophy of Science (1928). Einstein had been interested in the genetic studies which had been done concerning the conception of physical causality. Accordingly he proposed the following problem to be investigated by genetic psychology: Does the conception of velocity genetically presuppose the conception of time, or does it exist independently of the latter? Piaget then set to work, the story goes, and, after a series of experiments over several years, came up with a pair of books about children's conception of time and of motion and velocity (1945 and 1946).

From the standpoint of genetic psychology time may be defined as follows (Piaget (260)): Time is the process of mutual displacement between the units of two correlated series. And the coordination of serial motions with different velocities would determine the psychological "drag" of duration. The conception of time accordingly would consist of the comprehension of the correlation between two mutually displacing series. And since displacement involves motion, the concept of motion is theoretically prior to the concept of time. Genetically speaking, as we shall see, the formation of the conception of motion precedes that of the conception of time. The concept of motion in turn involves the concept of velocity. Velocity is here defined as the rate of displacement indicated by the ratio of time to space. These displacements being the displacement of the elements of a discrete series, the concept of seriation (serial order) seems to be related to the conception of time. Of the experiments performed by Piaget (260) (261) and his coworkers, which study the genetic interrelationship between the various aspects of the conceptions of time and of motion, only five will be briefly described.

Experiment I (Conception of Duration):

The apparatus consisted of a large sand-glass (45 centimeters in height). The lower half of the sand-glass, where the sand accumulated, was covered by an opaque screen so that the pile of sand might not distract the subject. The upper part of the sand-glass was marked with a simple scale: A white line was draw at 3/4 of the height, a green line at 1/2 of the height, and a blue line at 1/4 of the height. The flow of the sand between any pair of the lines on the scale corresponded to an equal interval of time. The subject was given a monotonous task, like transferring, one at a time, identical wooden cubes from one receptacle to another. And he was instructed by the experimenter to note the correlation between the amount of work done and the scale level of the sand in the sand-glass. The experiment was set up to study the relation between a measuring motion (sand flow) and a measured motion (subject's work). Consequently, after the first round, the experimenter asked the subject to vary the speed of his work, increasing or decreasing it, and to report his conception of the speed of the flow of sand in the corresponding durations of time. As a parameter a chronoscope, whose pointer swept a circle in one full minute, was set on the table; and the subject was instructed to transfer one object when the pointer came to a given point on the dial. Then he was to do the same thing fast or slowly; and answer whether the dial moved faster or slower. The results indicated three genetic stages in the evolution of the conception of duration. Stage 1 (ages 4–6 years): The subjects projected the speed of their subjective activity to the objective flow of sand: If they worked faster they claimed that the sand flowed faster also; and if they worked slower, the sand too flowed slower. The reaction of the subjects about the clock was the same: The pointer moved faster or slower as they moved faster or slower. Stage 2 (aged 6–8 years): The subjects recognized the duality of the subjective and objective processes, of their work speed and of the flow of sand; and regardless of the rate of the former, they recognized the constancy of the speed of the latter. Stage 3 (ages 8–10 years): The subjects not only recognized the independence of the subjective and objective durations of time, but also displayed a conception of the coordination between several different systems of durations.

Experiment II (Conception of Serial Time):

The apparatus consisted of two glass jars, fixed upon a stand in vertical order, placed upon the table. The upper jar (I) contained a colored liquid (H_2O), which the experimenter permitted to flow in constant amounts and at regular intervals into the lower jar (II). This was done by a stop-control fixed on the glass tube that led from jar I to jar II. The potential volumes of the two jars were equal, so that, after a complete displacement of the liquid from jar I to jar II, the latter would be full and the former empty. The quantity of partial displacements of the liquid at regular intervals corresponded to the units of an elevation scale alongside jar II. Thus it was possible for the subject to measure time by the height of the liquid in the glass jar. The experimenter periodically gave the subject a copy of a set of identical diagrams of the apparatus in order to mark, with a colored pencil, the level of the liquid in the two jars after every partial displacement. After the complete displacement of the liquid, that is the reversal of the contents of the two jars, the completed set of diagrams were given to the subject to be arranged in a coherent series. This was to be done once for both jars jointly and once for each jar separately. Thus in effect the subject was given the task of first reproducing a pair of ascending-descending series, and then establishing their serial correlation. After that the experimenter undertook a systematic interrogation with reference to the temporal aspects of the experience: Whether the serial order of the diagrams indicated a relation of before and after; whether the time intervals between two points of the ascending series and the corresponding points of the descending series were equal; whether the time intervals between two successive pairs of points in the ascending series or descending series were equal; whether the relation between the quantities of partial displacements of the liquid and the time intervals between these displacements was constant. The results indicated three genetic stages in the formation of the conception of serial time. Stage 1 (ages 4–6 years): The subjects displayed no conception of a temporal series. This was indicated by the fact that they were unable to arrange the diagrams into a coherent series; and that, when pressed, they denied the equality of the units of time as they were represented by the partial displacements of the liquid. Stage 2 (aged 6–8 years): The subjects displayed a partial conception of the time series. They successfully arranged the set of diagrams into a coherent series when the ascending and descending sets were presented together. But when only one of the two sets was presented they were unable to arrange it into a series. This indicates that while the concept of a series of events was formed at this stage, the comprehension of the correlation of a pair of series was still missing. Consequently while the subjects recognized the equality of the intervals of time corresponding to a pair of successive displacements of liquid, they did not recognize the equality of the intervals for the corresponding pair of the ascending and descending series. Stage 3 (ages 8–10 years): The subjects finally synthesized the concept of a series of events and the correlation between two series of events. As a result they recognized the constancy of the intervals of time corresponding to the successive pairs of events within a given series and also to the correlative points of two divergent series.

Experiment III (Conception of Motion: Linear Series):

Three colored balls (A = red, B = brown, C = yellow) were introduced into an opaque tube in the order ABC. The subject (ages 4–8 years) observed this process, but he could not see the balls after they were inside the tube. The subject was permitted to draw the colored balls on a piece of paper in the direct order ABC as a memory aid. The experimenter then interrogated the subject over a set of systematic problems: (a) What would be the order of succession of the colored objects when they come out from the other end of the tube (direct order)? (b) What would be their order of succession if they come out from the same end into which they entered (reverse order)? (c) What would be their order of succession from the same end and from the other end if the tube be rotated 180 degrees (inversion) and 360 degrees (inversion of inversion) respectively? The result of this experiment will be stated with that of the following related experiment.

Experiment IV (Conception of Motion: Circular Series):

A large hexagonal prism, every side of which was painted a different color (ABCDEF), was rotated before the subject (ages 4–8 years). And the subject was permitted to select from a supply of colored bands of paper the corresponding bands and affix them to a plate before him, in the order ABCDEF, as a frame of reference. Then the colorful prism was taken and placed by the experimenter inside a wooden box. It was fixed there upon a rotating bar, such that at any given time only one side of the prism, and therefore one color, could be seen through a narrow horizontal opening in the wall of the wooden box. Through a second opening was visible the continuous uniform motion of a blank screen as the prism bar rotated—so that the subject had a continuous perception of motion. The experimenter then interrogated the subject to indicate, by means of extra colored paper bands, the following circular series: (a) The direct order of the series after the first color (A) appeared at the opening. (b) The periodicity of the direct series after the last color (F) appeared at the opening. (c) The reverse order of the series when after the last color (F) the direction of rotation was reversed. (d) The periodicity of the reverse order after the last color of the reverse series (A).

Comparative Results: The results of the above pair of experiments indicate three genetic stages in the evolution of the conceptions of linear series and circular series. Stage 1 (ages 4–5 years): The subjects attained the concept of the direct linear series; but lacked those of the reverse linear series and direct circular series. Stage 2 (age 6 years): The subjects formed the conception of the reverse linear series and of the direct circular series; but they lacked the concept of the inversion of the linear series and those of the periodicity or inversion of a circular series. Stage 3 (ages 7–8 years): The subject attained at last the concepts of the inversion and inversion of inversion of a linear series, as well as the concepts of the periodicity and inversion of a circular series. Thus there was a generai parallelism between the genetic stages of the two concepts. The concept of circular series is more difficult to attain because it must first be transformed into the linear series to be comprehended.

Experiment V (Conception of Velocity):

Three pairs of toy locomotives were placed in separate areas upon a table. Each pair of locomotives and each individual locomotive within a pair was of a different color. There were three problems in the experiment: (a) In the first pair of locomotives one was parked some distance behind the other at the start, but their velocities were coordinated such that the last one caught up with the first one and they both arrived at the finish-line at the same time. (b) In the second pair, one locomotive was parked some distance behind the other at the start, but, in the course of the race the second locomotive overpassed the first one, arriving at the finish-line earlier. (c) In the third pair, the two locomotives were parked at opposite ends of the race track, so that they bypassed each other: once at the midpoint of the track, arriving at their respective finish lines simultaneously; and a second time, at an off-midpoint, arriving at their finish-lines anachronistically. The task of the subject was to determine the comparative velocities of the locomotives in each case. Again three genetic stages were discernible in the formation of the concept of velocity. Stage 1 (ages 5–6 years): The subjects showed no conception of velocity, for their sole criterion for the judgment of comparative velocity always turned out to be the order of arrival at the destination. Thus these subjects solved correctly only the second problem, but for the wrong reason. Stage 2 (aged 6–7 years): The subjects used, in addition to the criterion of the simultaneous arrival, the criterion of overpassing. So they solved both the first and second problems but not the third. Stage 3 (ages 7–8 years): The subjects formed the conception of velocity by an integration of the distance of motion with the time of termination and the ratio between them.

Conclusion

The conception of velocity gentically precedes the conception of time. Time appears to be the resultant of the coordinations of different velocities. Velocity itself is the product of the relations of order, specifically that of overpassing (*dépassement*). Thus the time formula of classical physics, which defined velocity in terms of the ratio of space and time ($V = S:T$), must be reversed: Time must be defined in terms of the ratio of space and velocity ($T = S:V$). In this respect the perspective of genetic psychology appears to be parallel to the perspective of modern physics (theory of relativity) which conceives of time as a "fourth dimension of space."

It is interesting to note that at about the same time (1946) that the work of Piaget (260) and his collaborators appeared in France, in this country Ames (12) published the result of her study of the conception of time. Ames experimented with about forty subjects (ages $1\frac{1}{2}$–8 years) at the Yale Clinic of Child Development. The experimenter observed their spontaneous play and interrogated them with a set of systematic questions involving the concept of time. These questions were concrete questions of the "when and what" type. The results indicated that the evolution of the concept of time undergoes a series of changes: Beginning with a limited conception of the present (ages $1\frac{1}{2}$–2), it extends to a conception of the future (ages 2–3), followed by a conception of the past (ages 3–4), and of duration (ages 5–6), terminating in a general conception of serial time (ages 7–8). The findings of Ames appear to be complementary to the findings of Piaget, and the two studies corroborate each other with respect to the time (age) of the attainment of the conception of time.

Critical Remarks

The critical remarks shall be confined to two points: First, that the definition of the concept of time adopted by genetic psychology is a circular definition. Second, that this definition of time, despite its psychological setting, is a physicalist definition. These two points will be briefly elucidated.

Piaget defines *time* as the process of displacement between the units of two correlated series. This serial displacement involves *motion* with a given velocity. This conception would then be a conceptual coordination of various but correlated velocities. *Velocity* in turn is defined as the *rate* of displacement indicated by the ratio of *time* to *space*. It is evident that, in this definition of time, the concept of time appears in both the analysandum and the analysans. And the resultant circularity of the definition renders it logically analytic.

To describe time in terms of physical displacements is to offer a physicalist definition of time. Such a definition may meet the requirements of the quantitative aspect of time (serial time) but it neglects the qualitative aspect of time (duration). Physics may have the prerogative of a limited interest in serial time; but psychology can afford to ignore the duration of time only at the cost of its *phenomenal subject-matter*. (The dichotomy between physics and psychology will be sketched in Chapter 8: Methodological Framework). It is sufficient to point out here that the perception of the *duration* of time is never the same as the perception of serial displacement. It will be instructive to introduce here the analogy of the phi-phenomenon in gestalt psychology: There, the perception of apparent motion itself is *not* identical with its serial elements. Introspective anecdotes are the bane of psychological texts, but in the far horizons of psychology, of which facts tell enough to make us suspect that there is more to tell, introspective contemplation is valuable if only to preserve scientific scepticism. Accordingly we shall report an anecdote from the Notebook of this writer: He has had the experience of traversing the classic Brooklyn Bridge (City of New York) many times, and distinctly recalls that, despite the optimal conditions for serial "displacement" and "overpassing" on the top level of that multilevel bridge with multilevel traffic, his perception of duration was disappointingly short. The span of this bridge is 1595½ feet, and the walking time is 7 minutes and 30 seconds. An equal stretch of distance traversed at the same pace, and void of the perception of multiple velocities, offers in contrast a protracted perception of duration. Indeed what psychologist can forget the duress of the public waiting-halls where, in the absence of all velocity, minutes expand into seemingly endless durations? If the perception of time were dependent upon the perception of velocity, then in the absence of all movement the experience of duration must approach the vanishing point; but we have seen that exactly the opposite of this actually takes place. The perception of the duration of time is more a function of the attentive set than of the traffic of events in the physical environment. And for that, the duration of time is not any *less* real: It still is, and will remain, a psychological reality for the objective psychologist. Törnebohm, the Swedish theoretical physicist, has constructed a logical schema, involving "dimensional analysis," for the reduction of the classical theory of physics (mass-space-time system) to the theory of relativity (mass-space system). But while the physicist may contemplate time as the "fourth dimension of space," the psychologist cannot very well do so without losing his phenomenological *subject-matter*. For example, in his recent study of the "psychology of time" Fraisse (96), of the University of Paris, refuses to investigate either the conception of time itself or its genesis but confines himself to the adaptive behavior of man in temporal situations. M. Fraisse of course, following the precepts of behaviorism, departs from the phenomenological tradition of European psychology. Such atypical tendencies in European psychology are the sundry expressions of the doctrine of physicalism which has been hounding psychology for at least seven decades.

IV. CONCEPTION OF CAUSALITY

The study of the genetic evolution of the conception of causality is complementary to the genetic study of the conception of nature: The latter being concerned with the *what*, and the former with the *why*, of events. In the experimental study of the conception of causality Piaget (257) employed three techniques: (1) The verbal presentation of questions concerning the causes of natural phenomena. (2) A combination of verbal and demonstrational interrogation. (3) Little experiments, illustrating sundry natural phenomena, were conducted in the presence of the subjects, who were then interrogated concerning their causal explanations.

The phenomena studied here were in general the same phenomena that were used in the study of the conception of nature which we have described previously. Without enumerating these phenomena again, and without describing the diverse little demonstrational experiments, the main results of this protracted investigation will be summarily stated (cf. Piaget (257)):

(1) The philosophical conception of natural law, that is the causal laws of the natural sciences, possesses two logical traits—logical generality and logical necessity. The psychological conception of the same evolves through three genetic stages. In the first stage (ages 4–8 years) the idea of generality is absent, and the idea of necessity is given a purely subjective interpretation. In the second stage (ages 8–10 years) the ideas of generality and necessity are differentiated but not adequately. In the third stage (ages 11–14 years) both the generality and the necessity of the natural laws are recognized and they are logically interpreted.

(2) The conception of causality undergoes a complex genetic evolution. Piaget and his collaborators have arrived at the conclusion that the child entertains, during the various stages of his psychological history, no less than "seventeen types" of causal conceptions. And Piaget has suggested that to these correspond seventeen kinds of causal questions (why-questions) frequently asked by children.

Not long after the publication of Piaget's researches concerning the conception of physical causality, Jean Deutsche (71) of the University of Minnesota, undertook an experimental study of the formation of the same concept. Her subjects consisted of school children between the ages of 8–16 years numbering 732. Two types of tests, both involving the questionnaire method, were employed: (1) The experimenter conducted a set of simple experiments, involving the phenomena of physical causation, and then required the subjects to write the corresponding causal explanations. Examples: (a) A lighted candle was placed on the table; a glass jar was then inverted over it causing the extinction of the extinction of the candle; and the subjects were to explain why the jar extinguished the candle. (b) A beaker containing H_2O was placed on the table; and subsequently other chemical liquids were added, which either changed its color successively or formed layers of colored liquids; and the subjects were to explain the causes of the succession of colors or the layers of colors. (2) A set of standardized causal questions were placed before the subjects, and their explanations were required in writing: The questions were about the causes of the winds, the snow, the shadows, the rain, the floating of the boats, the accidental simultaneity of similar events, and the like. The most noteworthy result of the experiment was that, while the responses of the subjects showed a continuous and gradual evolution of the conception of physical causality as a function of age, there was no evidence for the classification of causal reasoning into the "seventeen types" of Piaget. For, not only the operational meanings of these concepts were not clear and the standard criteria for distinguishing them absent; but also there were many responses which overflowed the "seventeen types," while some of these "types" could not be discerned at all in a representative sample of twelve thousand protocols of responses. Moreover, the educational history of the subject appeared to be an important factor in the formation of his causal conception; but the role of this factor has been underestimated by Piaget. It may be noted that, the absence of a distinct demarcation of the "genetic stages" in this experiment, may be attributed to its methodological limitations.

It may be observed that most of the experiments concerning the conception of causality involve phenomenal motions of various kinds. Now, while Piaget has rendered explicit the inherent relationship between the conceptions of time and motion, he has not investigated the relationship between causality and motion. For such an investigation the reader may be referred to the researches of A. Michotte (227) at the Université de Louvain. Michotte's experimental study of the perception of causality reveals two general forms, "launching" and "releasing," the former having an inverse relationship, and the latter a direct relationship, to the velocity of the moved object relative to the velocity of the mover. However, the conception of causality, in contrast to the perception of causality, takes various other forms.

Theoretical Critique:

An analysis of the Piagetian "seventeen types" of causal conceptions, from the phenomenological standpoint, reveals that they are simply variations of four basic types. Had Piaget himself, the great morphologist that he is, performed such a morphological analysis, it would have prevented much critical scepticism. It is sufficient to note that Piaget's laborious classification mixes the *content* of causality with the *form* of causality. And this constitutes a violation of a basic principle of natural philosophy to the effect that: There is no logical justification for distinguishing different "types" of phenomena when their family traits (form) are identical but only the instances (content) are different. Only by neglecting this principle is it possible to enumerate seventeen or more varieties of causal conceptions (And the experiment by Deutsche (71), described above, illustrates this point very well). In the following four basic types of causal conceptions—of which Piaget's "seventeen types" are variations—will be outlined.

(1) Paralogical conception of causality. The basic trait of this type of causal explanation consists in that both empirical validity and logical consistency are absent from it. This conception comprises *five* of Piaget's "seventeen varieties" of causal explanation: "motivational causality, finalism, phenomenistic causality, participation, magical causality" (ages 4–6 years).
(2) Subjective conception of causality. The fundamental trait of this type of causal explanation is that the subject introjects his subjective states into the etiology of natural phenomena. This conception comprises *four* of Piaget's "seventeen varieties" of causal explanation: "moral causality, artificialist causality, animistic causality, dynamic causality" (ages 6–8 years).
(3) Naturalistic conception of causality. The basic trait of this type of causal explanation consists of its systematic employment of a naturalistic etiology: Both cause and effect are considered to be natural phenomena. This conception comprises *seven* of Piaget's "seventeen varieties" of causal explanation: "surrounding medium, mechanical causality, substantial generation, substantial identification, condensation and rarefaction, atomistic composition, spatial explanation" (ages 8–10 years).
(4) Logical conception of causality. The fundamental trait of this type of causal explanation is the employment of the principle of sufficient reason (The principle of sufficient reason states that there is a reason for everything, and that the explication of this reason constitutes a sufficient causal explanation). This conception comprises the last of the "seventeen varieties" of causal explanations: "explanation by logical deduction" (ages 10–12 years).

V. CONCEPTION OF QUALITY

The concepts of logic are described as *qualitative*, in contrast to the concepts of mathematics which are *quantitative*. The discussion of the topic of quality will consist of two parts: (1) The genetic evolution of the concepts and principles of logic. (2) The psychological aspects of the analytic and synthetic conceptions.

1. Logical Conceptions

It may be recalled that "operational logic" was defined as the logical study of psychological configurations. "Genetic logic" may be defined as the psychological study of the concepts of logic. The blue-print for "genetic logic" was anticipated by the American psychologist J. M. Baldwin (23) in his pioneering work on genetic psychology; and to Piaget (266) belongs the credit for having achieved a systematic realization of that blue-print.

The basic concepts and principles of logic have been previously reviewed (cf. Chapter 2). They consisted of: the concept of class, the concept of relation, logical constants, logical quantifiers, logical operators, the principle of contradiction, the principle of transitivity, the principle of equilibrium, and the concept of probability. A set of experiments, which have empirically studied some of these concepts and principles in their specific forms, will be briefly described here.

Experiment I (Classification and Seriation):

In a series of closely connected experiments on the genesis of the elementary logical structures, Piaget and Inhelder (284) studied the formation of the concepts of classification and seriation in approximately 2000 subjects (ages 4–9 years). A variety of special tests were employed in the context of the psychogenetic method. The results indicated that there was a genetic parallelism in the evolution of these concepts. In general there were three stages of evolution discernible: In the first stage the subjects perceived the class and the series as perceptual figures and nothing more. In the second stage the subjects recognized in the perceptual class and the perceptual series the general traits as their respective criteria. In the third stage the subjects recognized all the basic traits of the perceptual class and the perceptual series as a system of criteria, that is, they attained a logical comprehension of the concepts of class and series. Thus the main process in the evolution of these concepts was the transition from the perceptual extension of the figure to the operational intension of the corresponding concept. And this process was an autonomic process in which, in addition to the data of perception, the anterior structures of the subject and his state of equilibrium played a fundamental role.

Experiment II (Concept of Class):

This experiment was performed by Piaget (267). A box contained wooden cubes (class A), all of which were brown (class B) except for a few which were white (class C). The subjects (ages 5–8 years) were then asked by the experimenter whether the box contained more wooden cubes or more brown cubes. The results revealed three genetic stages: In the first stage (ages 5–6 years) the subject did not comprehend the concept of class and class-inclusion. He did not answer that obviously there were more wooden cubes than brown cubes, for *all* the cubes were made out of wood. He did not see that (class B + class C) = (class A) and that (class A — class B) = (class C). He failed to realize the part-whole relationship of class-inclusion, but only concentrated upon the parts *or* the whole at one time. Hence his typical answer to the problem: There are more brown cubes than wooden cubes because there are very few white cubes, that is, B > A because B > C! In the second stage (ages 6–7 years) the subject had an elementary conception of class but not that of class-inclusion. And although his response to the problem was generally correct, the reason for it was not the recognition of the logical relationship between classes. He observed that there were more individual members in class A than in class B, but he did not come to this conclusion by logical deduction. In the third stage (ages 7–8 years) the subject displayed a comprehension of the concepts of class and classinclusion. He solved the problem correctly, by logical reasoning, on the basis of the combination of the two classes (B and C) into a third class (A).

Experiment III (Principle of Transitivity):

This experiment (Piaget (266)) consisted of the presentation of three bars (A.B.C.) in a setting of depth perception. It was explained to the subject that the length of A was equivalent to the length of B, and that the length of B was equivalent to the length of C. Then the subject was asked whether he thought that the bars A and C were of equal length. The subjects before the ages 7–8 years did not recognize the equality of the two lengths and were distracted by the perceptual aspects of the situation. They were not able to perform the perceptual transposition of a constant relation, because they had not yet formed a conception of the principle of transitivity, $[(A = B \cdot B = C) \rightarrow (A = C)]$.

Experiment IV (Principle of Contradiction):

It may be suggested that the subject develops a sensitivity to logical inconsistency (contradiction) analogous to acquired sensitivity to physical threats. For just as the physical threat disturbs the physiological homeostasis of the organism, so logical contradiction disturbs the psychological equilibrium of the rational organism. In this respect the principle of contradiction, $(p) - (p \cdot - p)$, is a natural law of thought—in the same way that the principle of homeostasis is a natural law of bodily functions.

The following experiment (Inhelder and Piaget (145)) on the law of floating bodies illustrates that the conception of logical consistency itself evolves gradually. The subjects were given a number of disparate objects, and asked: (a) To classify them with respect to their floating properties; (b) To explain the basis for their classification; (c) To test their classification by the observation of the behavior of those objects in beakers containing H_2O; (d) To summarize their observations and state the principle that will explain them. The responses of the subjects represented three stages of development: Stage 1 (aged 6–7 years): The subjects neither attributed the floating phenomena to a single property of the object, nor did they seek to find the law that governed these phenomena. Instead they were content with explaining the floating of objects with reference to their various properties, despite the fact that such explanations were often contradictory. Stage 2 (ages 7–9 years): The subjects did attempt to explain their observations of floating bodies with reference to a single factor namely the relationship of the weight of the object to its volume; but the law of floating bodies was still not discovered. Stage 3 (ages 11–12 years): The subjects attributed the floating of objects to their density (relationship between weight and volume) and specific gravity (relationship between densities of solids and H_2O), and discovered the law of floating bodies: The density of the floating bodies is less than the density of water. Thus it is on the basis of the logical principle of contradiction that the subject begins to think with logical consistency.

Experiment V (Concept of Disjunction):

This experiment was performed by Inhelder and Piaget (145). A pendulum, consisting of an object suspended by a string, was presented to the subjects. The independent variables were the length of the string, the weight of the object, and the amplitude of oscillation. The problem to be solved was to find out the determining factor for the frequency of the oscillation of the pendulum. The three stages indicated by the responses of the subjects were: Stage 1 (ages 6–7 years): The subject considered the impetus exerted by himself upon the stimulus as the determining factor in the frequency of oscillations. Stage 2 (ages 8–10 years): The subject realized the empirical relationship between the various variables and the frequency of oscillation, but this observation did not lead to any conceptual generalization. Stage 3 (ages 11–13 years): The subject was at last able to isolate the determining factor by the method of varying a single variable at a time and holding all other variables constant. And in order to arrive at this result the subject utilized both empirical observations and the framework of combinatorial logic. The one furnished a system of actualities, and the other a system of possibilities; and the answer lay in the proper combination of the two. (These possibilities are represented by the system of 16 binary combinations which have been reviewed in Chapter 2).

Experiment VI (Concept of Implication):

This experiment was performed by Matalon (84: XIII–XIV). The apparatus consisted of a panel with two colored lights (red and green). The experimenter stated to the subject the relation of implication between the two light spots: Whenever the red light came on then the green light followed it: $(p \rightarrow q)$. Then the experimenter interrogated the subject according to the mode of ponens $[(p \rightarrow q) \cdot p] \rightarrow q$ and the mode of tollens $[(p \rightarrow q) \cdot -q] \rightarrow -p$. The results indicated three genetic stages in the formation of the conception of logical implication. In the first stage (ages 6–7 years) the subjects displayed no comprehension of implication and identified it with equation; in the second stage (ages 9–10 years) the subjects comprehended the mode of ponens; and in the third stage (ages 11–12 years) they acquired a comprehension of the mode of tollens.

Experiment VII (Concept of Equilibrium: Compensating Vessels):

The apparatus of this experiment (Inhelder and Piaget (145)) consisted of a pair of vessels different in volume and shape. They were connected by a rubber tube and placed upon stands whose heights could be varied by a lever. The raising and lowering of the vessels by the subject, by varying the height of the stand, resulted in a change in the level of H_2O in the receptacles. The relevant variables were the height of the vessel and reciprocal pressure as a function of height. The problem was to explain the inequality of the liquid levels between the two vessels at unequal heights. The three stages of the responses given by subjects were as follows: Stage 1 (ages 4–7 years): The subjects explained the inequality of the liquid levels with reference to their own adjustment of the height of the stand. Stage 2 (ages 7–10 years): The subjects explained the phenomenon with reference to the height variable. They often stated the inverse relationship between the relative height of the vessel and its liquid level (Given two compensating vessels, the higher vessel will have a lower liquid level and the lower vessel a higher liquid level). Stage 3 (aged 11–13 years): The subjects explained the liquid level with reference to the state of equilibrium based upon the reciprocal pressure of the contents of vessels, and the reciprocal pressure with reference to the relative heights of the vessels. Thus the concept of equilibrium was not at all known in the first stage; it was partially formed in the second stage; and it was fully grasped in the third stage. The difference between the second and the third stages was that the former understood only the changes in the level of liquid but not their compensatory nature. The reason for this in turn is that the prerequisite for this understanding is the comprehension of the four fundamental operations of INRC (Identity . Inversion . Reciprocity . Correlativity) (cf. Chapter 2). The second stage subjects comprehended the operation of *inversion* (changes in liquid levels) but not *reciprocity* (compensation of pressure by changes in liquid level); but the third stage subjects comprehended both these operations and consequently the operation of equilibrium (The logical conditions of equilibrium and grouping have been described in Chapter 2: II).

Experiment VIII (Concept of Equilibrium: Seesaw Balance):

The apparatus of this experiment (Inhelder and Piaget (145)) consisted of a seesaw balance with two unequal weights (W_1 and W_2) balanced at unequal distances (D_1 and D_2) from the axis. The problem was to discover the principle of equilibrium for the seesaw balance. This principle may be stated as follows: The ratio of the unequal weights is inversely proportional to the ratio of the unequal distances: $W_1/W_2 = D_2/D_1$. The responses of the subjects were classified into three stages. Stage 1 (ages 4–7 years): The subjects attributed the cause of the equilibrate state of the seesaw balance to their own actions of adding and subtracting weights. Therefore, given an unbalanced state, they would add more weights, not on the lighter side alone, but on both sides simultaneously; hoping to bring about somehow the equilibrium in this way. Stage 2 (ages 7–10 years): The subjects were able to empirically reproduce the equilibrate state in the balance, by the correspondence of the lesser weight and greater distance with the greater weight and lesser distance, but they could not state the principle. Stage 3 (ages 10–13 years): The subjects conceived the principle of equilibrium ($W_1/W_2 = D_2/D_1$) through the concept of compensation. And the concept of compensation, as it was seen in the experiment with the "compensating vessels," presupposes the logical framework of the four fundamental operations of INRC (Identity . Inversion . Reciprocity . Correlativity .). The reader may recall the operational formula (cf. Chapter 2): (o) (Io/Ro = Co/No) where o = operation. In the light of this logical formula it is evident why third stage subjects alone were able to comprehend the principle of equilibrium in the seesaw balance: The key to this comprehension was their interpretation of equilibrium as a system of compensation based upon reciprocity of forces.

Experiment IX (Concept of Equilibrium: Weight—Counterweight Balance):

The apparatus of this experiment (Inhelder and Piaget (145)) consisted of a toy truck placed upon an inclined track, and held by a cable, at the higher end of the track, with a weight suspending from it along a vertical bar. The independent variables were the weight of the load on the truck (M), the counterweight suspended by the cable (W), and the inclination of the track measured by the sine of the angle (height of the vertical bar) (H), and not by the angle of declension, the length of the track (L) being constant. The problem was to find the principle of equilibrium for this mechanical situation: $W/M = H/L$. The responses of the subjects were classified into three stages: Stage 1 (ages 4–7 years): The subjects were able to conceive of the equilbrium as a function of only two variables (the weight of the truck load and the counterweight at the end of the cable). They neglected the effect of the inclination of the track. Stage 2 (ages 7–10 years): The subjects conceived the equilibrate state to be a function of all three variables (M, W, H); but they did not have a conception of the principle involved. Stage 3 (ages 11–15 years): The subjects not only saw the relevance of all three variables but also demonstrated a conception of the principle of equilibrium involved: The ratio of the two opposing weights is directly proportional to the ratio of the intersecting distances ($W/M = H/L$). And this conception of equilibrium by the third stage subjects is possible—as in the case of the experiment with the "compensating vessels" and the experiment with the "seesaw balance"—on the basis of the logical framework of the four fundamental operations of INRC (Identity. Inversion. Reciprocity . Correlativity.) (cf. Chapter 2: II).

Experiment X (Conception of Probability):

The conception of probability is in the last analysis a logical conception. An event is described as "probable" when it is a member of a class of events with a relative frequency. An inference is described as "probable" when it is one of a class of arguments whose conclusions are true with a relative frequency given the truth of their premises. Behind the principles of the calculus of probability, there are two main theories of probability: (1) The frequency theory which states that the probability rate of an event is equivalent to the ratio of the number of positive cases to the number of actual cases (actual cases = positive cases + negative cases). (2) The range theory which states that the probability rate of an event is equivalent to the ratio of the number of positive alternatives to the number of possible alternatives (possible alternatives = theoretical alternatives). In any case the probability of an event is the limiting value which the relative frequency of the event approaches in the long run. The probability value of an event is described by a mathematical fraction whose range always lies between 0.00 (impossibility) and 1.00 (certainty). Genetic psychology has been concerned with the formation of the conception of probability as the relative frequency of an event.

In an experiment by Piaget and Inhelder (282) four sets of pebbles, with different colors and numbers, were placed upon the table: For example: 15 yellow units, 10 red units, 7 green units, and 3 blue units. The experimenter also placed upon the table four sets of markers, corresponding in colors and numbers to the pebble sets. Then he took the pebble sets and put them in a bag which he joggled well. The task of the subject (ages 4–12 years) was to predict the color of the pebbles before they were drawn out of the bag one at a time. The drawn pebbles were replaced on the table, alongside the markers, for the subject's verification. The result indicated three stages in the formation of the conception of probability. Stage 1 (ages 4–7 years): The haphazard behavior of the subjects indicated the absence of the conception of probability. Stage 2 (ages 8–10 years): The subjects displayed a conception of the probabilities of a serial system; but there was no quantification of probabilities, for the subjects did not subtract the actual cases from the possible cases in order to estimate the probability of the remaining cases. Stage 3 (ages 10–12 years): The subjects displayed both the conception of the probabilities of a serial system as well as the quantification of probabilities.

Experiment XI (Conception of Probability):

The objective of this experiment (Matalon (84: X)) was to study the genetic aspects of the learning of aleatory and systematic probabilities. The subjects were children (ages 5–8 years) and adults. The experiment consisted of two parts:

(1) In the first part a train of events was set in, in which a pair of alternative events occurred in aleatory fashion: The probability of one event was p (= 0.70) and of the other event 1 − p (= 0.30). More specifically, an object was hidden under two separate covers in aleatory alternation, and the subject was to learn the probability of its appearance for each cover. The results showed that the younger children tended to repeat the response most frequently rewarded with a higher degree of probability than the probability of its reinforcement; while the older children, with a lower degree of probability. And although the acquisition of aleatory probability was roughly equal in both groups, these divergent tendencies on the part of the younger and older

subjects indicated the subjective propensity of the former and the relatively objective propensity of the latter. For the young subjects seemed to concentrate more on their responses, and the old subjects more on the results of their responses.

(2) In the second part of the experiment the train of events was alternated in a systematic fashion. A panel with a pair of light-bulbs (red and green) was used. The experimenter turned the lights on and off in the standard order of double-alternation (AABBAA...). The younger subjects had more difficulty in apprehending the principle of probability involved than the older subjects, because here again they concentrated on their responses and neglected the results of the responses.

The formation of the conception of probability may be explained with reference to the formation of the four combinatorial operations of I–N–R–C (cf. Chapter 2). It may be noted here that research in American genetic psychology has revealed that subjects attain the conception of probability at an earlier age than that indicated by European genetic psychology: An experiment by W. S. Hunter—which placed candies in a pair of boxes in a double-alternation order—has demonstrated that children grasp that concept at the age of 4–5 years.

Conclusion

The results of these experiments indicate two things: (1) That the concepts of logic are often the necessary condition for the formation of other types of conceptions. (2) That the concepts and principles of logic themselves are interrelated in their genetic history. In a recent theoretical study Grize (84: XIII–XIV), of the University of Geneva, has described the genetic interrelationship of logical concepts as the "filiation of logical structures."

These phenomena of genetic psychology do not confirm the thesis of classical empiricism (Locke and Mill) to the effect that the concepts of logic are generated by perception. We have seen that perception is not the sufficient condition for the formation of logical conceptions; and that logical conceptions are the products of the autonomic processes of the subject (cf. Chapter 3: II). In this respect there is a partial affinity between genetic psychology and the epistemological theories of Kant (157).

2. *Analytic and Synthetic Conceptions*

The classic statements of the analytic-synthetic dichotomy have been given by Kant (157) and Frege (97). According to Kant, a proposition states a relationship between a subject and a predicate in two ways: Either the predicate is contained in the concept of the subject or it is not contained in the concept of the subject. In the former case the proposition is analytic; in the latter case synthetic. According to Frege, the analytic proposition is deducible from a set of purely logical concepts and laws, while the synthetic proposition is derived from a set of factual protocols. The two statements of the analytic-synthetic dichotomy are complementary: Analytic and synthetic propositions have their characteristic *forms* (Kant) because they have had their respective *grounds* (Frege). Both statements recognize that analytic propositions are *a priori*, and that their negation involves contradiction; that synthetic propositions are *a posteriori*, and that their negation involves no contradiction.

Accordingly, it may be noted that there is a fundamental difference between the "analytic" and the "tautology." *Analyticity* means the representation of the structure of the same idea by a different logical cross-section; and tautology, in contrast, means that the same structural cross-section is expressed by a different symbolism (language). The loose usage of the term "tautology," and its identification with "analyticity," in the context of contemporary philosophy (especially the school of linguistic formalism), is to be attributed to the oversight of this basic distinction.

Recently a logical controversy has been waged over the logic of the dichotomy between the analytic and the synthetic. Some contemporary logicians (notably W. V. O. Quine), having found the proposed definitions of analyticity to be ambiguous, have proposed that the analytic-synthetic dichotomy be rejected as an ambiguous bifurcation. However, attending, solely to the semantics of analyticity, they appear to have altogether overlooked the syntactic aspect of analytic propositions. Consequently, they have interpreted the distinction between the analytic and the synthetic, which is essentially a dichotomy of forms, as if it were a dichotomy of contents. But it is their logical forms, not their contents, that distinguish analytic propositions from synthetic propositions. And the analytic-synthetic dichotomy is a methodological dichotomy for the classification of propositions into the categories of the empirical (inductive) and theoretical (deductive). It may be concluded, then, that this dichotomy, as Herbert Feigl (88) has observed, is a perfectly valid dichotomy in the context of the philosophy of science.

Piaget and his collaborators (274) too have criticized the analytic-synthetic dichotomy from the standpoint of genetic psychology. Their argument is based upon a set of three experiments which they have performed. The most noteworthy of these consisted of giving the subjects (psychology students) a list of propositions. The list contained analytic and synthetic propositions in random order; and the subjects were interrogated with regard to their classification on the basis of a corresponding set of criteria. The results indicated that in many cases a clear-cut classification was not obtained. The other pair of experiments consisted of the solution of analytic-synthetic problems by the subjects (children); and the results indicated again, not a clear-cut dichotomy, but a continuous differentiation between the analytic and the synthetic.

It may be noted here that the conclusion of these experiments against the validity of the analytic-synthetic dichotomy is not conclusive. These experiments do not prove that this dichotomy is untenable. They only prove that it is susceptible to a genetic evolution and that this evolution transcends the conceptual framework of the layman. And this does not constitute any negative evidence for the logical validity of the analytic—synthetic dichotomy—unless the comprehension of the layman be made the criterion of truth! Let the reader contemplate the consequences of this criterion for our sciences. And yet it is precisely on the basis of the limitations of the comprehension of the layman that these experiments reject the validity of a time-honored philosophical dichotomy. There is a limit to the scope of genetic psychology, and it has reached that limit here: For the borderline between any natural science and the philosophy of science constitutes the *Grenzbegriff* of that science.

VI. CONCEPTION OF QUANTITY

Three aspects of the conception of quantity will be discussed here: The conception of the conservation of matter, the conception of material atomism, and the conception of number. These three aspects are interrelated in this way: The conception of material atomism constitutes the transition between intensive quantity (conservation of matter) and extensive quantity (conception of number). A set of experiments, which have studied the genetic evolution of these different aspects of the conception of quantity, will be briefly described.

Experiment I (Conception of Conservation of Matter):

The apparatus of this experiment (Piaget (267)) consisted of a pair of identical beakers (A_1 and A_2), containing equal quantities of a colored liquid (H_2O), placed upon the table. The subject was permitted to

verify the equality of the contents of the two receptacles by placing them side by side and noting the level of the liquid in each. Then the experimenter poured the contents of the beaker A_2 into: (a) A beaker with a different shape (e.g. taller or wider) (F). (b) A pair of smaller beakers (B_1 and B_2), and again poured the contents of B_2 into a pair of still smaller beakers (C_1 and C_2). The task of the subjects (aged 4–7 years) was to state whether: (i) The amount of liquid in beaker F was equal to that of beaker A_1? (ii) Whether the contents of A_1 was equal to the contents of ($B_1 + B_2$); and the contents of $B_1 + (C_1 + C_2)$ was equal to the contents of A_1; etc. A comparative statement of the results of this experiment will be given with that of the following experiment.
Experiment II (Conception of Conservation of Matter):

The technique of this experiment (Piaget and Inhelder (281)) was as follows: The subject (ages 4–12 years) was seated before a table upon which was place a pellet of argil. He was then given material to make another pellet equal in size and weight. Once the identity of the two pellets was recognized by the subject, the experimenter took one of the two and changed its shape (e.g. elongated, flattened, or broke it into separate pieces). The subject was then interrogated as to whether the two pellets still had the same amount of matter, the same weight, and the same volume (volume was determined by displacement of water in a container in which the objects were immersed). Having ventured an answer, the subject was asked to give the reasons for his answer.
Comparative Results: The results of the above pair of experiments indicated that there were three aspects to the conception of the conservation of matter. In their genetic order they were: The conservation of substance, the conservation of weight, and the conservation of volume. The conception of conservation appeared to evolve through four genetic stages (In general the stages in Experiment I occurred somewhat earlier than the stages in Experiment II). Stage 1 (ages 4 to 7–8 years): The subjects did not recognize any form of conservation whatever. Stage (2 ages 7–8 to 10 years): The subjects recognized the conservation of substance but not those of weight or volume. Stage 3 (ages 10 to 11–12 years): The subjects recognized the conservation of substance and weight but not that of volume. Stage 4 (ages 11–12 to 14–15 years): The subjects recognized all three aspects of the conservation of matter (substance, weight, volume). The typical explanations of the various forms of conservation were as follows: The conservation of substance was explained with reference to the absence of additive-subtractive operations. Thus the subjects would say that the material remains the

same, despite the variation of its shape, because nothing has been added to it or subtracted from it. The conservation of weight was explained with reference to the conservation of substance: The weight of the same material remains unchanged because its substance had remained unchanged. The conservation of volume was explained with reference to the conservation of weight and substance: The volume remains constant because the weight of the material, and consequently the substance of the material, has remained constant. Thus the conception of the conservation of substance appears to be basic for the conseptions of other types of conservation are derived from it.

Experiment III (Conception of Material Atomism):

The technique of this experiment (Piaget and Inhelder (281)) was as follows. The identical beakers of water, three-fourths full, were placed upon the table. The subject (ages 4–12 years) was permitted to verify the equality of the amount of liquid in the two receptacles by placing them side by side and noting the level of the liquid. The experimenter then placed a cube of sugar in one of the beakers, and let it be dissolved completely. The subject, who witnessed the whole process, was asked by the experimenter if the contents, weights, and volumes of the two beakers were still equal. The four genetic stages, which we have just noted in the case of the conception of conservation, essentially recurred in the case of the conception of material atomism. Thus, at first there was the belief that the piece of sugar perished as it dissolved; afterwards, that it changed into particles of equal amount but with varying weight and volume; then, that the substance and weight of the particles was conserved; and finally, that the particles of the dissolved piece of sugar retained their substance, weight, and volume. Thus the concept of material atomism reveals the same genetic history as the concept of conservation of matter. The difference between the two being that in the latter case the persistence of matter is discerned through the variations of shape; and in the former case, through the dispersion of body into particles.

Experiment IV (Conception of Number: Numerical Correspondence):

In this experiment (Piaget (267)) two identical cylindrical containers (A and B) were placed upon the table next to a pile of wooden cubes. The subject (ages 4–7 years) was instructed to put one cube in container B every time the experimenter put one in container A. They both started and stopped simultaneously. The subject was permitted to admit the numerical equality of the contents of the two containers. Then the experimenter took container B and emptied its contents into a container of a different shape (e.g. taller or wider), or, into a pair of smaller identical containers. The subject was then interrogated about the numerical equality of the contents of the latter and container A. A comparative statement of the results of this experiment will be given with that of the following experiment.

Experiment V (Conception of Number: Numerical Series):

In this experiment (Piaget (267)) the subject (ages 4–7 years) was given a set of ten sticks (ABCDEFGHIJ) of various lengths and instructed to arrange them in a series ranging from the shortest to the longest. When this was accomplished, the subject was given another set of ten sticks (abcdefghij), and he was told that these had been forgotten and that they must be inserted in the appropriate places within the first series. The combined asymmetrical series would contain 20 units: AaBbCcDdEeFfGgHhIiJj. The intra-series differences between the lengts of the sticks were approximately 0.8 centimeters; and the inter-series difference between the lengths of the sticks was approximately 0.4 centimeters. The combined series ranged in length from 9.0 to 16.0 centimeters.

Comparative Results: The responses of the subjects in the above pair of experiments indicated three genetic stages. Stage 1 (ages 4–5 years): The subjects neither possessed the conception of numerical correspondence nor of numerical series. For they neither recognized the numerical equality of the wooden cubes after the changes of their containers, nor were they able to arrange the sticks into a numerical series. Stage 2 (ages 5–6 years): The subjects displayed a partial knowledge of the concepts of numerical correspondence and numerical series. They admitted the numerical equality of the cubes with reservations after their containers were changed; and while they arranged the first series of sticks correctly, they had difficulty in incorporating the second series. Stage 3 (aged 6–7 years): The subjects formed the conceptions of numerical correspondence and numerical series. They realized that the numerical aspect of objects is not affected by extraneous variations; and they readily constructed the numerical series on the basis of the principle of asymmetrical series.

Experiment VI (Conception of Number: Numerical Infinity):

In this experiment (Morf (84: XIII–XIV)) the experimenter asked the subjects (ages 9–12 years) the following simple question: Is there a greatest number? The answers given reflected two stages. Stage 1: The subjects (ages 9–10½ years) answered that there was definitely a maximum number but that it was displaceable by another maximum number. Stage 2: The subjects (ages $10\frac{1}{2}$–12 years) answered that there was no maximum number because given any maximum number it could be exceeded by a higher number indefinitely.

Conclusion

The genetic evolution of the conception of number may be outlined as follows (Piaget (267)): First, the subject forms the conception of class (classification). Second, the subject forms the conception of asymmetrical relation (seriation). Third, the subject forms the conception of numerical correspondence between classes. Fourth, as a result of the correspondence of classes, the subject forms the conception of the "class of classes" which is number. The conception of a complex mathematical equation—like $1 + 2 + \dots + n = \frac{n(n + 1)}{2}$ to take an example from Wertheimer (335)—would involve the concept of number plus a complex set of logical concepts.

According to Piaget (84: XI) the concept of number is constructed out of logical components exclusively. These logical components begin to be accessible to the subject at the beginning of the operational period (ages 7–8 years). The concept of number is the synthesis of the concepts of class and relation. Specifically, number is the synthesis of the grouping of combinatorial classes and the grouping of iterative asymmetrical transitive relations. This quantitative process is described as "recurrence" (Poincaré: *récurrence*). James (146–II), in contrast, has described it as the iteration of attention. Leaving this controversial point aside, it is noteworthy that the genetic theory of Piaget and the logical theory of Frege and Whitehead-Russell alike consider arithmetic to be the product of logic. Furthermore the logical components of the conception of number in the two theories are the same. The only difference between these theories is that in the logical theory the concept of number is "discovered" by the subject by means of logical deduction, but in the context of the genetic theory it is "constructed" by the subject out of logical elements.

It may be noted that what has been said previously, about the genesis of the conception of quality (concepts of logic), also applies to the genesis of the conception of quantity (concept of number). Perception is not the sufficient condition of the formation of the abstract conceptions of thought. Ratter, a logical framework, consisting of a system of abstract conceptions, and developed in an autonomic fashion (constructive abstraction), is the necessary condition for the proper interpretation of perceptions as well as for the formation of conceptions. Consequently, the interpretation of the formation of concepts proposed by the thinkers of classical empiricism (notably J. S. Mill) is not tenable. And again we have here an instance of a philosophical error which is generated by an erroneous psychological presupposition. The genetic theory (Piaget), like the theory of logical realism (Frege and Whitehead), realizes that number is not a property of physical objects, but rather a higher level concept (class of classes), that is, an abstract entity.

Critical Remarks

We have seen that, from the standpoint of genetic psychology, the conception of number represents the logical synthesis of the concept of class and of relation. To recognize the fact that the conception of number is, in the last analysis, the genetic product of logical concepts, whatever the nature of the process, and to simultaneously deny that the reduction of arithmetic to logic is in principle possible, that mathematics is a branch of logic, appears to be the epitome of logical inconsistency. Yet Piaget (267) (84: XI) and his collaborators entertain such ambivalent thoughts with regard to the logic of mathematics. The net result of this ambivalence is ambiguity, the profoundness of which the reader may estimate for himself. In the following the main argument against the reduction of arithmetic to logic will be stated together with its critique.

In a recent paper Papert (84: XI), of Cambridge University, has argued that the logical reduction of arithmetic to logic is impossible *in principle*. Let the system of logic (formal system) and the system of arithmetic (intuitive system) be represented by S_1 and S_2 respectively. Let the elements of S_2 be p_1, p_2, ..., pn; the totality of these elements be P; and the systemic rules be L. The logical relation of reduction then holds between the two systems, when to every element of S_2 there corresponds an element in S_1 by the reductive rule (f). Thus to p in S_2 corresponds f(p) in S_1; and to P in S_2 corresponds f(P) in S_1. We then have the "logical equation": $p \equiv f(p)$. Papert asks: What criteria do we have for the validity of such a reductive equation? And he means by this question: Granted the meaning of f(p) (logic), how do we know the meaning of p (mathematics) in order to know whether their equation is valid? It cannot be the reciprocal implication involved, for it would only show the mutual but independent truths of the terms; nor can any appeal be made to the semantic-syntactic principles of the two systems, for this would require arithmetic to be a formal system which it is not; nor can the intuitive meanings of the reduced system be invoked, for it would clearly be a case of *petitio principii.* The three alternatives being closed, Papert concludes, logical reductionism is *in principle* unjustifiable.

Briefly our critique may be stated as follows. The basic flaw of this argument consists of its misconception of the operation of "logical reduction" as it is understood in contemporary philosophy of science. It overlooks the logical conditions of reduction, finds itself facing a problem which it cannot solve, and throws the blame upon logical reductionism. Following Ernest Nagel (234), of Columbia University, we may state the logical conditions of reduction as follows: (1) The laws and hypotheses of the two sciences are explicitly formulated, and their constituent elements have definite meanings fixed by the rules of usage. (2) Every proposition of the reduced science is analyzable into elements according to their rules of construction, and these elements have fixed meanings according to their rules of usage. (3) The two sciences have in common a number of concepts which have the same meaning in both contexts: These are the elements borrowed by the reduced science from the reducing science. (4) The reduction may take place in principle: It is sufficient that the basic concepts of the reduced science be reducible to the reducing science; the rest will be derivable from the basic concepts. It is evident that logic (reducing science) and mathematics (reduced science) fully conform to these logical conditions of reduction. In the light of this fact three consequences follow: First, the reductive relation between logic and arithmetic (e.g. reductive equation) correlates the "contextual meaning" (rules of usage) of the reduced element to the "structural meaning" (description of structure) of the reducing element. Second, the element in the reducing science (logic) is to be taken as a structural definition of the element in the reduced science (mathematics). Third, the reduction literally confers a structural meaning, in terms of the structural elements of the reducing science, to the elements of the reduced science—which had hitherto only a contextual meaning—and in this lies the epistemological value of logical reductionism.

From a purely logical point of view, mathematics presupposes many logical concepts (e.g. logical constants) but logic does not presuppose any mathematical concepts. This conceptual debt on the part of mathematics is enough by itself to demonstrate the logical priority of logic to mathematics. The classis arguments against logical reductionism have been: (1) The finite nature of the classical logical system which appears to be inadequate in the light of the modern conception of an axiomatic system as an "open system" (Gödel's theorem).

(2) The alleged circularity of the logical definition of the concept of number. But these arguments are directed against a particular logical system and not against the possibility of logical reductionism itself. And even if we grant these problems of detail, logical reductionism would still remain a possibility in principle: For the basic concepts of arithmetic can be interpreted and defined logically, and consequently, all arithmetic can be conceptually derived from logic by logical principles. The psychological value of logical reductionism consists of the fact that it illustrates the natural filiation of the abstract configurations of thought. And the philosophical value of logical reductionism consists of the fact that, by giving a logical meaning to the concept of number, it emancipates the philosophy of science from the agelong "mystery of numbers." However, mathematics irreducibly transcends arithmetic.

VII. GENERAL CONCLUSION

We have now arrived at the end of our systematic review of the representative experimental studies of genetic psychology (French Phase). Let then their essential theoretical contribution and import be recognized and stated before everything else: Firstly, these studies have succeeded, to a great measure, in providing a scientific description of the various aspects of the ontogeny of the operations of thought, ranging from the elementary groupings to the abstract configurations at higher levels. And secondly, these studies have demonstrated, with remarkable consistency, the genetic autonomy of the abstract conceptions of thought from the lower processes of perception. It will be reserved for the "genetic theory of thinking" to provide the interpretation of this complex set of empirical discoveries and of its general results (cf. Chapter 5: II).

Our concluding observations will be confined to the examination and clarification of a methodological point inherent in these studies, which has been occasionally suspected by sundry critics, and which threatens, if remaining neglected, to be so associated with the whole school as to propagate the ambiguity of a few experimental cases to the rest. From the very beginning of the publications of this school, American psychologists have criticized the researches of European genetic psychology for their relative negligence of the history of the subjects. The genetic psychologists, however, have persistently maintained that the history of the subject is irrelevant to the natural evolution of his fundamental conceptions (cf. Piaget (256) and Inhelder & Piaget (145)). It is thus that the controversy between the historical and the ahistorical theses begins; and this controversy is partially due to the semantic ambiguity of the term "history." For, given the essentially historical perspective of the genetic psychology, it is not correct to say that it neglects the history of the subject altogether: What the genetic psychology neglects is the "*environmental history*" of the subject, but it is necessarily and profoundly concerned with the "*natural history*" of the subject. It is evident that the psychological framework of the organism is the product of both natural evolution and historical environment. And these two essential factors determine the psychological constitution of the organism in different ways: The evolutionary factor is relevant to the *form*, and the environmental factor to the *content*, of the psychological system. Accordingly, the cognitive world of the subject may be analyzed into the "concrete knowledge" (factual information) and the "abstract knowledge" (logical framework). While the potentiality for the forms of the abstract knowledge is determined by natural evolution, the attainment of the concrete knowledge is determined by the historical environment. Further, while the logical framework of the subject serves as a selective determinant of the assimilation of the factual information, the latter in turn contributes to the development of the former by way of abstraction. It is not merely, then, that the environment determines the psychological constitution of the subject, but also the subject determines the shape of the environment. And this is what the genetic psychologists mean when they reassert the oft-repeated dictum to the effect that: "*Au commencement était la réponse.*" Consequently, the environmental history of the subject appears to be relevant to the psychological development of the subject in a very limited way, namely, to the extent that it determines the *content* of the cognitive world. It follows that the genetic psychologist, disregarding much of the environmental history of the subject, may still objectively study the *form* of his cognitive world. This is in fact what the genetic theory of thinking has attempted to accomplish; and this too is the reason why the psychologists of the French Phase (especially Piaget) pay little attention to the environmental background of the subject. However, after everything has been said in its vindication, there remain the traces of a methodological inconsistency in the researches of genetic psychology: Granting the irrelevance of the historical environment to the study of the operations of intelligence, genetic psychology frequently engages in the investigation of the concrete knowledge of the subject (This is especially true of some experiments concerning the physical events and mathematical objects). As a result of this illicit transition, the concrete knowledge of the subject is sometimes taken as the index of his intelligence, while disregarding the educational history of the subject. Indeed, nowhere is the critique from the American psychologists more germane and justified than it is here where an uncontrolled variable is introduced into the experimental investigation. And it is to be attributed to the same recurrent confusion that genetic psychologists have sought to describe an alleged similarity between the presocratic philosophers and children with respect to their explanations of natural phenomena (cf. Piaget (256)). It is evidently overlooked that the seeming similarity is not between their intelligence but between the impoverished states of their factual knowledge. It would indeed be a preposterous proposition to compare the pure intellect of the classic founders of natural philosophy to the nascent reasoning of the modern thing-bound children.

It may be concluded that the researches of genetic psychology, when consistent in their own methodological practice, are defencible against criticism; and that, if they are subject to criticism, it is because they have become methodologically inconsistent. If, then, the source of a prevalent theoretical misunderstanding has been clarified, relative to the experimental studies described in this chapter, we shall leave these studies and turn from the experimentation to the theory. A general methodological critique of genetic psychology will be reserved for later (cf. Chapter 8: I).

CHAPTER 5

PSYCHOLOGY OF THOUGHT PROCESSES

The objective study of the thought processes, classically known as the "higher mental processes" in the history of experimental psychology, was undertaken by contemporary cognitive psychology, despite the physicalist trend that prevailed during the second quarter of the present century, for two main reasons. On the one hand, the experimental investigation of *perception*, beginning with the nature of elementary sensations, had led necessarily to the problem of *apperception*, involving the comprehension of a meaningful series of perceptual configurations in retrospection. And, on the other hand, experiments with animal *learning*, beginning with simple reflex conditioning and advancing to the cognitive operation of problem solving, had led necessarily to the problems of *concept-formation* and *hypothetical reasoning*, which represented but special manifestations of the general process of thinking. Accordingly, the converging lines of experimental research, which led from the analysis of perception and learning to the threshold of thought processes, at last discovered that the thought processes constituted, simultaneously, the context of meaning for the text of perception as well as the covert psychological function for the overt behavior of learning. Concluding that neither the spontaneous process of the *lecture de l'expérience*, nor the operation of experimental learning and its transfer, could be explained without reference, however oblique, to the underlying thought processes, contemporary psychology resumed, where classical psychology had left off, the systematic investigation of this central problem.

In view of the above observation, it is all the more remarkable that the empirical study of the "higher mental processes," despite their explanatory potential and their introspective validity, should have been abandoned in the context of American psychology, as they were for almost a quarter of a century, in favour of the exclusive study of language and "verbal report" which, paradoxically, presupposed the authenticity of introspection and introspective inference. Contemporary psychology has demonstrated that it is no longer necessary to rely upon the old method of "direct introspection" exclusively, for the scientific investigation of cognitive phenomena, which are susceptible to analysis by qualitative experimentation. Yet, behaviorism, in its period of predominance (1925–1950), appeared to have persuaded itself, as well as its following, to the effect that the psychology of the "higher mental processes" was hardly anything more than the statistics of rote learning. The argument was rather plain: If the thought processes consisted of elements in association, then the learning of elementary associations, without any theoretical context, constituted the foundation of all thinking. Adopting the principle of elementism from classical psychology (Wundt), together with the principle of association from classical empiricism (Locke & Mill), while neglecting the critical principle of "mental chemistry" in both contexts, behaviorism sought to formulate the doctrine of "behavioral atomism" (cf. especially Hull (141)). Accordingly, the proponents of the "S-R theory" (represented variously by Skinner (321) and by Spence (323)) were to maintain that the thought processes had essentially no psychological reality, in the context of their methodology, and that even if they did, they would remain inaccessible to scientific investigation. However, the contemporary renaissance of functional psychology, which has sought the explanation of behavior (including language) in the "intervening variables" of cognitive and emotive processes, and which has reformulated the stimulus-response relationship, as "S — (O) — R" (that is: $R = f(S+O)$), corroborates the researches of European cognitive psychology. It will be the main objective of the present chapter to examine, not only the problem of the phenomenal reality of the thought processes, but also their logical necessity for the scientific explanation of the learning phenomena.

We shall examine the nature of the thought processes under the comparative light of genetic psychology and gestalt psychology, both of which are reinforced by the animal studies of contemporary ethology, and represent the dominant trends in European cognitive psychology. Both trends, being essentially complementary, reinforce each other; and together they contribute to the results of objective psychology. The family resemblance between these two schools, to which we have alluded in a previous context, manifests itself again here: There is the historical transformation of the structural perspective, owing to gestalt psychology, which was subsequently adopted by the German Phase as well as the French Phase of genetic psychology. Accordingly, both schools make a natural transition, by means of the concepts of "structure" and "equilibrium," from the theory of perception to the theory of thought processes, and both employ the qualitative methods of experimentation with a very high degree of precision. It is noteworthy, then, that both schools interpret the process of learning to be a function of the underlying thought processes; and that, consequently, the psychology of thought is conceived to lie at the foundation of learning phenomena. So theoretically interlaced are the ramifications of these two psychological trends, that for their full comprehension and evaluation a comparative examination is necessary, especially since it is their collective contexts, and their complementarity, that restore to the study of the "higher mental processes" their classical significance but with rigorous experimentation and a markedly different theoretical framework.

I. THE GESTALT THEORY OF THINKING

The psychological interpretation of thought processes has taken three historical forms: It has employed the hypothesis of "elementism" as the basis of its analysis (Wundt); it has explained the phenomena of thought with reference to the concept of "process" (James); and, finally, it has sought to interpret the varieties of thought processes with reference to the concept of "structure" (Köhler). It is this third line of interpretation which is adopted by the gestalt theory, and which, in this context, represents a theoretical synthesis between the hypotheses of elementism and dynamism. From an objective point of view, neither the theory of elementism nor the process theory can be regarded as dispensable altogether; on the contrary, they still remain highly germane to the theoretical repertoire of contemporary psychology. Of course, we are no longer inclined to speak of the "mental chemistry," analytically interpreted, but only with a synthetic interpretation. Nor is the concept of the "stream of consciousness" to be used, without great modification, in the context of the "field theory" of consciousness. However, despite these fundamental theoretical transformations, the fact remains that the classical theories have left a permanent conceptual deposit in the gestalt theory. And the great value of the gestalt theory lies, not in a radical repudiation of the positive contributions of classical psychology, but in the achievement of a theoretical synthesis in the light of which the limitations of classical psychology are transcended. In the following pages we shall sketch the gestalt theory of thought processes from a comparative standpoint, treating of its German Phase as well as of its American Phase.

1. *The Concept of Gestalt*

The theoretical transition from the interpretation of the perceptual processes to the thought processes is by means of the concept of *gestalt.* The two basic meanings of this concept, corresponding to the two areas respectively, have been explained previously (cf. Chapter 3: I). Accordingly, in the context of the present chapter, it is the "Ø-gestalten" (perceptual configurations), which will be of special relevance. For, while the former displays the phenomenal "emergence" of a configurational property, the latter possesses the trait of configurational "transcendence." And the capacity of the Θ-gestalt for transposition is determined by its configurational transcendence: The phenomena of transposition, observed by Köhler (173) and by Klüver (165), constitute the experimental illustration of the formation and functioning of the Θ-gestalten. The chickens of Köhler learnt to transfer the conception of an achromatic pattern from one context to another; and the apes of Klüver acquired the ability to apply a general principle of problem solving to several different problems. The Θ-gestalten and the Ø-gestalten are, not merely logically different, but also psychologically different. In the context of thought processes, in contrast to perception, the psychological transformation of the elements to the gestalten requires a proportionately greater time. In the psychological medium, between the elements and the corresponding gestalten, there are the *Vorgestalten* (infraconfigurations), which indicate the various states of structural transformations with relative degrees of nascent equilibrium. The concept of "Vorgestalt," as it has been investigated in the researches of Lorenz (206), indirectly, and Conrad (66), directly, acquires a special significance in the context of the psychology of thought processes. As it has been noted previously, a logical analysis of the concept of gestalt has been given by Grelling and Oppenheim (114). However, that analysis is confined solely to the methodological aspect of this concept; and our logical analysis in a later chapter will be relevant to the phenomenological aspect of the same concept, that is, the problem of the reducibility of the concept of gestalt to a set of physicalist concepts (cf. Chapter 7: II).

2. *Principle of Prägnanz*

It is through the process of "structuring" (*Gestaltbildung*) that the discrete elements of perception and thought group themselves, first into the *Vorgestalten*, and finally into the gestalten. The psychological law that regulates this process is the "principle of prägnanz," which describes the natural tendency of configurations toward a state of figural equilibrium. A configuration which has achieved a high degree of stability and compensatory mobility is a "good figure." Thus the principle of prägnanz is an explanatory principle: For it explains the assimilation of the minimal properties of the configuration into its maximal properties, and accordingly, the transformation of the *Vorgestalt* into the gestalt. The structural aspects of the equilibrium of psychological configurations have been described in the classic works of Köhler (171) (174). The principle of prägnanz has been adopted by genetic dsychology, and it will be examined in greater detail in that context.

3. Insight and Transposition Phenomena

"Insight" may be described as the comprehension of the basic structure of the problematic situation, that is, the comprehension of the functional relationship of the parts to the whole. All learning then, to the extent that it consists of the learning of patterns, may be considered to be the product of insight. From the gestaltist point of view, the old controversy over "trial-and-error" versus "insight" is to be resolved in the following way: The initial attempts of trial-and-error are the first natural steps which will eventually terminate in an insight into the nature of the solution pattern. One cannot make a career out of "trial-and-error"; for in that case, in the absence of any "insight" whatever, it would become the "method of stupidity." However, even lower animals manifest some degree of intelligence, and consequently, insight. The classic study of the behavior of the higher apes by Köhler (169) has demonstrated the incidence of insight in problem solving. And, with respect to this phenomenon, American functional psychology corroborates the results of gestalt psychology: Thus, for example, Tolman (342) speaks of "cognitive maps" in human beings as well as in white rats with relative degrees of complexity; Harlow (122) (123) of "learning sets" underlying the organized response patterns of rhesus monkeys; and Krechevsky (187) of the genesis of operations resembling "hypotheses" in white rats. Whatever the variations in the manifestations of the forms and degrees of insight, the basic traits of insightful behavior have been described by Yerkes (374: p. 520f) in his systematic study of the anthropoid psychology:

(i) Survey, inspection, or persistent examination of problematic situation.
(ii) Hesitation, pause, attitude of concentrated attention.
(iii) Trial of more or less adequate mode of response.

(iv) In case initial mode of response proves inadequate, trial of some other mode of response, the transition from the one method to the other being sharp and often sudden.
(v) Persistent or frequently recurrent attention to the objective or goal and motivation thereby.
(vi) Appearance of critical point at which the organism suddenly, directly, and definitely performs required adaptive act.
(vii) Ready repetition of adaptive response after once performed.
(viii) Notable ability to discover and attend to the essential aspect or relation in the problematic situation, and to neglect, relatively, variations in non-essentials.

In the context of the gestalt theory, the phenomena of transposition (transfer of the Θ-gestalt between different contexts) is explained with reference to the concept of insight. For transposition presupposes the comprehension of isomorphic gestalten by the subject. The whole class of transposition phenomena, observed in chickens by Köhler (173), in white rats by Lashley (194), in monkeys by Klüver (165) and Harlow (122), illustrate the essential relationship between insight and intelligent problem solving. As for the phenomenon of "reverse transposition," observed by Spence (323) in the behavior of chickens under extreme conditions, it indicates nothing more than the fact that the *permanence* of the Θ-gestalt is relative to the various levels of intelligence in the phyletic scale: The higher we go in the phyletic scale, the higher the intelligence, and the more permanent the Θ-gestalten. It is logical then to expect that there will be less reversal of transposition in the apes than in the chickens, far less in children, and that there will be none in the rational man. Consequently, far from constituting any evidence against the gestalt theory, the phenomenon of the reversal of transposition, whatever of it there is, supplements the results of the gestalt theory. In fact, gestalt psychologists have always stressed the relatively of intelligence in the lower animals, and have pointed out that certain experimental contexts, by their very design, make it impossible for these animals to display insightful behavior (cf. Köhler (173)). The limited mentality of animals does not constitute any evidence for the mechanistic psychology. As Lashley (194) has demonstrated, the phenomenon of generalization in animals (and in men) constitutes the sufficient refutation of the simple association theory. The remarkable gap between the capacity for insight in man and lower animals remains. But, as Köhler (169) has observed, "even with little insight many things become easy which could never occur by accident."

4. *Principle of Reorganization*

According to the gestaltist interpertation, the process of thinking may be described as a constructive and reconstructive operation: The thinking subject repeatedly reconstructs the problematic situation until a transformation is obtained which provides an insight into the hypothetical solution. This involves the "principle of reorganization," which has been described by Köhler (173), and investigated with greater detail by Duncker (78). A typical case of reorganization consists of: (a) The analysis of the structure of the problematic situation (the gap). (b) The analysis of what is needed to remedy the situation (the goal). (c) The application of the criterion of "functional value," that is, every object and every idea is seen in the light of its possible relevance to the solution of the problem. (d) The reinterpretation and restructuring of past experience (history of associations), on the basis of the criterion of functional value, toward the attainment of a solution. In a series of experiments on problem solving by Duncker (78), the subjects were given problems which could not be solved on the basis of their past experience, which necessitated ignoring the past associations or even operating against them, and which were finally solved by subjects as a result of the selective reorganization of their past experience. Suffice it to refer to the "X-Ray Problem": The subjects, confronted with the problem of the projection of high intensity x-rays upon an infected internal organ without burning the intermediate tissues, necessarily had to operate contrary to their past experience (e.g. the adoption of a direct one-track approach in this case), in order to achieve the correct solution of sending a number of low intensity x-rays from different points of the body. Even the intelligent behavior of the lower animals often displays, albeit at a very elementary level, a reorganization of their past experience. Relative to this, Maier's experiment (211) on "reasoning" in white rats may be recalled: The rat was permitted to acquire general familiarity with three tables together with their adjoining paths (Experience 1); then the same rat was fed upon table A (Experience 2); and when this animal was placed upon table B, it ran to table A where it had been previously fed. The conclusion, pointed out by Maier, is clear: Such a bit of behavior cannot be interpreted to be the result of associative learning but of the cognitive integration of experiences 1 and 2 (reasoning); for the rat had never taken that path to food but had always been obliged to climb up the food table from the ground. In his intensive study of the nature of hypothetical thinking and problem solving, Van de Geer (344) of the University of Leiden, has arrived at theoretical results which corroborate the gestaltist hypothesis of reorganization. The hypothesis of reorganization, then, implies that the behavioristic "S–R theory" of problem solving, being based upon the principle of association exclusively, remains quite inadequate. And the viewpoint contributed by Van Parreren (347), as a theoretical compensation for the sundry limitations of mechanistic psychology, is essentially compatible with the general hypotheses of the gestalt theory.

5. *Principle of Direction*

Whether we speak of restructuring (Köhler), of recentering (Wertheimer), or of reorganization (Duncker) of the cognitive elements, the psychological process of problem solving remains essentially the same: A state of disequilibrium and strain, resulting from a deformed situation, is resolved by changing the structure of the situation toward the attainment of a good configuration. Obviously, this change cannot be an arbitrary event, if it is to solve a problem; and the reconstruction must take place in a certain *direction* in order to offset the strain in the system. The experimental studies of Maier (212) (213), concerning the nature of reasoning in children and in adults, have demonstrated that "direction," as an organizing principle, is the necessary condition for problem solving. The set of experimental problems (namely, the "String Problem," the "Pendulum Problem," and the "Rack Problem)," which he gave to subjects, were solved with far greater frequency in the presence of a directive sign. Further, it is noteworthy that Maier's gestaltist and functionalist instructions provided a direction that nearly doubled the frequency of problem solving:

> (a) Locate a difficulty and try to overcome it. If you fail, get it completely out of your mind and seek an entirely different difficulty. (b) Do not be a creature of habit and stay in a rut. Keep your mind open for new meanings. (c) The solution pattern appears suddenly. Keep your mind open for new combinations, and do not waste your time on unsuccessful attempts.

It has been discovered that two other factors, besides instructions, contribute to the determining of the direction in problem solving and hypothetical thinking: Firstly, there is the influence of the knowledge of abstract principles which are applicable to various concrete situations; and, as Székely (332) has experimentally demonstrated, often the knowledge of an abstract principle is *more* effective than a collection of factual information. Secondly, as Saugstad and Raaheim (310) of the University of Oslo have shown, there is the pervasive influence of the relative availability of the functional meanings of the objects in the given context.

6. *Einstellung and E-Effect*

The "Einstellung" (cognitive set) may be described as a general Θ-gestalt that determines the formation of other, lower level, gestalten. And the effect of the determining gestalt upon the determined gestalt is called the "E-effect." The genesis of specific "Einstellungen" and the functioning of the E-effect have been investigated in the American Phase of gestalt psychology. As the most representative of these studies, we shall refer to the systematic experiments of Luchins (207). The experimental group was given two sets of problems, which consisted of obtaining a specified volume (V) of liquid (H_2O), given three jars of specific volumes (A, B, C). The first set of problems established the Einstellung: The subjects learnt the formula $V = B—A—2C$). The second set of problems showed the E-effect: While the required formula was $V = (A \pm C)$, the subjects persistently strove to apply the old formula. The experimental group retained the complicated and impossible formula in the face of new problems, but the control group readily discovered the simple and correct formula. The E-effect, of course, may be either negative or positive. And, generally speaking, the Einstellung is far more influential in the context of thought processes than in the context of perception.

7. *Productive and Reproductive Thinking*

According to the gestalt theory, the phenomena of thinking may be classified into two categories: There is the "productive thinking," which consists of configurational thinking, that is, the comprehension of the structural aspects of the problematic situation and the restructuring of the same into a good configuration. And there is the "reproductive thinking," which consists of the rote representation of learnt associations, which may or may not be relevant to the problematic situation. In the absence of a configurational framework, this latter kind of thinking remains piecemeal, and it has been therefore called "ugly thinking" by Wertheimer. The basic traits of productive thinking, as they have been described by Wertheimer (364), are the following:

(i) The apprehension of the problematic situation and its gap.
(ii) The structural analysis of the problematic situation.
(iii) The structural reorganization of the situation by the operations of recentering, differentiation, and integration.
(iv) Comprehension of the logic of configurations—their groupings, their hierarchies, and their transpositions.
(v) The search after "structural truth" (patterns of ideas) rather than "piecemeal truth" (bits of facts).

The experimental studies of Wertheimer (364) have demonstrated that, generally, when reproductive thinking fails, in problem solving, productive thinking succeeds. And, from the gestaltist standpoint, the psychology of scientific thinking throws light upon the logic of scientific discovery. It may be noted here that the gestalt theory supports the phenomenological interpretation of logic which we have previously discussed; for what Wertheimer calls "gestalt logic" and what Piaget calls "operational logic" are variations of the same structural system of logic. Finally, it may be noted that the gestaltist diagnosis of the two general kinds of thinking has profound implications for pedagogy.

8. Hypothesis of Psychophysical Isomorphism

Gestalt psychology, as well as functional psychology, have maintained that the principles of the peripheral nervous system are not sufficient for the explanation of the processes of the central nervous system. It is pointed out that, while the former involves "mechanical processes," susceptible of a mechanistic interpretation, the latter involves "functional processes," representing higher level integrations, which are susceptible of a functional interpretation. The researches of Köhler and his collaborators in the area of physiological psychology, during the last decade, have resulted in the formulation of the hypothesis of "psychophysical isomorphism" with great precision. According to this hypothesis, there exists a topological, but not a topographical, parallelism between psychological configurations and the corresponding physiological fields. Psychological configurations, as molar entities, involve figure and ground. When there is a difference between the brightness intensity of the figure and the ground, then they are pervaded by electric currents, such that the inside current and the outside current flow in opposite directions. Hence, the prolonged inspection of a figure will have distorting aftereffects upon the succeeding figure when the latter is presented in the same region of perception. With reference to this general hypothesis, which entails the dynamics of "electrotonic satiation" and of equilibrium, may be explained the phenomena of "displacement" in perception: Namely, that the inspection of a later figure, in the region of an earlier figure, manifests a marked displacement, especially relative to the original contour. These phenomena, and the related variations of aftereffects, have been investigated and described by Köhler and Wallach (185) and by Köhler and Emery (181) as well as by Gibson (104). Assuming the existence of a psychophysical parallelism, the problem that remains is concerning the nature of the physiological correlates of psychological configurations. The systematic experiments of Köhler (176) have led to the conclusion that these physiological correlates consist of a special field of "cortical currents." The properties of these currents are the following: (a) They have a very low range of frequency (below 10 cycles/second) in contrast to the standard currents recorded by the electroencephalograph (e.g. the alpha-wave and the beta-wave which range from 10 to 20 cycles/second respectively). (b) They are characterized by functional continuity, and consequently, they are not subject to the laws of the peripheral nervous system (e.g. the law of "absolute refractory period"). (c) They are topologically stable and permanent, having a pervasive scope, and they are capable of redistribution without being topographically limited. (d) The currents do not constitute an homogeneous and statistically satiated plane, as it were, but have levels of satiation. Accordingly, Köhler (177: p. 154) makes the observation that the phenomenon of memory is to be explained with reference to the levels of these currents: "Time is spatially represented in the brain just as it is in the geological strata on the surface of the earth." This observation is consistent with the hypothesis of the "permanent record of the stream of consciousness" developed by W. Penfield (250) at McGill University. The existence of the "cortical currents" have been experimentally demonstrated and analyzed by Köhler and Coworkers (178), especially in the field of pattern vision (Köhler & Held (183)), and in the area of the auditory perception (Köhler & Wegener (186)), as well as in the visual and auditory perception of the cat (Köhler & Coworkers (179) (184)). Regrettably, the scope of the present chapter does not permit a discussion of these valuable studies in greater detail. Suffice it to observe that, despite their highly original thesis, corroborative evidence is to be found in the context of both European and American researches. The classic studies of Lashley (190) (192) are consistent with those of Köhler, with respect to their demonstration of the absence of specific "physiological loci" for learning processes, and with respect to their defence of the "hypothesis of equipotentiality" against the "hypothesis of connectionism." Further confirmatory evidence is to be sought in the writings of Buytendijk (53) and Ajuriaguerra (5), both maintaining that the concept of "configuration," because of its functional entailments, is necessary for the description and explanation of the higher physiological processes of the nervous system. For the critical problems of the hypothesis of psychophysical isomorphism, whatever of it there is, the reader may be referred to the reviews written by Köhler (176) (177) and Prentice (290). The general significance of the studies connected with this hypothesis lies in that, although they have been so far confined to the field of perception, they indirectly throw light upon the ultimate nature of thought processes.

9. Pathological Thought and Gestalt Theory

The complex etiology of the phenomena of psychopathology reveals that pathological thought is, directly or indirectly, a determining factor. And the varieties of pathological thought recur with sufficient regularity to be susceptible of a general classification into phenomenological types on the basis of their family traits: (i) stereotypy, (ii) agnosia and aphasia, (iii) dissociation, (iv) disorganization, (v) concrete thinking, (vi) autistic thinking, (vii) projection, (viii) paralogical reasoning, (ix) distortion of perspective, (x) absence of the reference framework. The etiology of these variations of pathological thinking are represented by the general categories of the "somatogenic cases" (psychological disorders resulting from physiological dysfunctions) and the "psychogenic cases" (psychological disorders resulting from psychological dysfunctions). The latter category, in turn, is determined by the cognitive factors or emotive factors, or by the interaction of these two sets of factors together (cf. Dunbar (76)). Assuming the validity of this classification, the demonstration of which lies beyond the scope of the present task, the theoretical consequences of the gestalt theory may be summarily noted. From the standpoint of the gestalt theory, all psychological disorders involve, in one form or another, the destruction of a basic psychological structure and the concomitant generation of a "bad configuration." The result of this negative transformation is a pervasive disturbance of the equilibrium of the psychological system as a whole. Accordingly, the concept of "disease" in abnormal psychology may be defined as an essential deterioration of the structure of the system, whether resulting from the loss of physiological homeostasis or of psychological assimilation. And the concept of "cure" in psychotherapy may be described as the process of the reconstruction of the psychological system and the resultant restoration of its equilibrium. From the standpoint of the gestalt theory, classical psychoanalysis fails to explain the nature of this critical psychological transformation in psychotherapy. From the eidetic studies of Rorschach to the neurological studies of Goldstein (109) the explanatory value of the concept of "configuration" has remained constant. However, since this brief discussion is intended as a supplementary note to the gestalt theory of thought processes, we shall refrain from the examination of "gestalt therapy" here (cf. Perls & Hefferline (252)). Suffice it to observe that, if the consequences of the gestalt theory are highly significant for clinical psychology, they are equally significant for the pedagogy. For, if the gestaltist analysis of thought processes be valid, then the pedagogical disciplines must renounce the employment of the method of rote learning and piecemeal teaching. The majority of the socalled "objective tests" represent only the information of the subject concerning bits of facts, without any theoretical comprehension, and this does not deserve the name of "knowledge." Of course, the whole class of piecemeal data are necessarily doomed to follow the course described by the "forgetting curve" of Ebbinghaus. It is only the system of general conceptions that has any great permanence; and which, as a family of abstract configurations, is susceptible of spatial and temporal transference. Indeed, it is in the light of abstract conceptions that factual data acquire their relative significance and value. The essence of the European education, which has proved its excellence consistently, consists in the judgment of this author of nothing but the intellectual determination to place facts in their proper place, that is, always within a framework of abstract ideas, and never permit statistics to prescribe values. If educators are to train the intelligence of the youth to be "productive" rather than "reproductive," they must themselves learn to despise the fashionable overindulgence in the varieties of "physicalist techniques." If the academic disease of "pedantry" has infested modern scholarship (especially the socalled "social sciences"), it is precisely because the institutions of "higher learning" have sought to correct the tendency toward "autistic thinking" by the propagation of "piecemeal thinking." It is overlooked that both of these extreme forms describe the limits of "realistic thinking" and the very *Grenzbegriffe* of critical reflection. The simple truth, that empirical facts *and* abstract ideas, analysis *and* synthesis, constitute the necessary elements of constructive thought, remains in the underground of the contemporary *Zeitgeist*, which on the surface of it is haunted by the intrinsic relationship between education and psychopathology.

10. Conclusion: Critique of Modern Behaviorism

The fundamental relationship between the gestalt theory and the genetic theory, besides the fact that the basic concepts of the former are adopted by the latter, consists also of their parallel consequences in the context of theoretical psychology. However, before examining these consequences, the internal relationship of the two theories must be established explicitly.

Gestalt psychology has had a profound influence upon both the German Phase and the French Phase of genetic psychology. The genetic *Ganzheitspsychologie* as well as the genetic *psychologie opératoire* employ the structural perspective in their experimentation and theory construction. It has been noted before that the genetic psychologists of the German Phase interpret the concept of ontogeny in terms of the process of gestalt-formation (cf. Höhn (138)); and, further, that Piaget (272) considers the concepts of "configuration" and "equilibrium" to be the permanent contributions of gestalt psychology to the theoretical interpretation of the processes of perception and thought. However, these essential concepts have not remained altogether unchanged in the context of the French Phase. The principle of equilibrium has acquired an operational interpretation ,in this context, and the concept of gestalt has been given a gravely one-sided interpretation. Accordingly, Piaget (266) has even criticized gestalt psychology for the alleged reduction of the processes of thought to the processes of perception through the concept of gestalt. This criticism is based upon the assumption that there is only one kind of "gestalt," namely, the perceptual gestalt. But such an interpretation of the concept of "gestalt" is inadequate; for, as we have seen, gestalt psychology recognizes two main types of gestalten, corresponding to the phenomena of perception and of thought, respectively. Indeed, the "perceptual structure" (*structures perceptives*) and "logical structures" (*structures logiques*) of genetic psychology correspond to the "perceptual gestalten" (*Ø-gestalten*) and "conceptual gestalten" (*Θ-gestalten*) of gestalt psychology; and the "concrete operations" and "abstract operations" of the former correspond to the lower level and higher level Θ-gestalten respectively. It is because of this theoretical parallelism that gestalt psychology and genetic psychology, with their complementary frameworks of transverse and longitudinal analyses, both have recognized the functional autonomy of thought processes, the pervasive range of the organic law of equilibrium, and the subsidiary place of learning and language. It is logical, therefore, that European psychology should remain highly critical of any school which reverses the natural order of things; that studies the physical behavior of organisms and neglects their underlying psychological processes; that places the external activity of language before the internal process of thought; and that, consequently, pretends to derive the higher mental processes from the elementary operations of rote learning, rather than conversely.

Our critique of the theoretical framework of behaviorism will be brief: It will be confined to those aspects of modern behaviorism which are incompatible, not merely with European psychology, but with natural science and epistemology as well.

Historically, modern behaviorism constitutes a continuation of German elementism, especially with respect to their successive debts to the classical empiricism. Accordingly, the "principle of atomism" and the "principle of association" constitute the theoretical foundation of both the "mental chemistry" of Wundt as well as the "S–R theory" of contemporary behaviorism. It may be recalled that Wm. James (146) pointed out that the principle of association, taken by itself, was not sufficient for the explanation of the phenomena of thought; and that, without the "continuity of consciousness," it would be impossible for the process of association itself to occur. And he rejected psychological atomism, on the grounds that the phenomena of retrospection, which presuppose the continuity of thought processes, constitutes a sufficient counterevidence. Indeed, the very contemplation of psychological atoms, their review and comparison, constitutes the clearest repudiation of the doctrine of atomism. In this respect, both elementism *and* behaviorism may be regarded not merely anticonfigurational, but also antifunctional. Consequently, James, noting the absence of "relations" in classical empiricism and classical psychology, found them guilty of "half-empiricism," and demanded their impeachment: "These words are meant to impeach the entire English psychology derived from Locke and Hume, and the entire German psychology derived from Herbart, so far as they both treat 'ideas' as separate subjective entities that come and go" (James (146-I: p. 196)). The "radical empiricism" which James offered as a substitute required that the psychological reality of objects as well as the relations between objects be recognized. And it is for this reason that James may be regarded, not merely the founder of functional psychology, but also, as Thorndike (337) has noted, the forerunner of the American Phase of gestalt psychology. It is true that associationism resurrected, after James, in the form of "connectionism" (Thorndike (338)), but only to be repudiated again by the "theory of equipotentiality" (Lashley (191) (194)). The experimental studies of Lashley demonstrated that the phenomenon of generalization in animal learning could not be explained by the hypotheses of connectionism and reflexology. This appeared to have put an end to associationism, but not to the doctrine that the psychology of thought processes consists of nothing but the processes of associative learning.

The gestalt theory then turned its critical attention from the examination of elementism to associationism. In an essay on the nature of associations, Köhler (172) argued that, while behaviorism explains the genesis of cognitive operations with reference to the concept of association, the genesis of association itself cannot be explained except with reference to the concept of gestalt. For the formation of an association consists of the formation of a configuration; and the principles of the latter process constitute the regulatory principles of the former process. Thus what Hull (141) called a "family of habits," being the product of associations, turns out to be a family of "good gestalten." It may be noted that gestalt psychology does not deny the reality of the phenomena of association, but rather the hypothesis that the process of association constitutes the sufficient explanation of thought processes.

Modern behaviorism might provide a sufficient explanation for the performance of the electronic automata; but the performance of these automata is *in principle* different from the behavior of biological organisms. Cybernetics, the mathematical byproduct of operational behaviorism, has attempted to ascribe functional "nonlinearity" to biological organisms, in contrast to the "linearity" of mechanical systems. But, what cybernetics has labelled with the negative term of "nonlinearity," constitutes in fact the positive trait of "originality" in biological organisms: Namely, the capacity for the restructuring of experience and the formation of new configurations. There is not, accordingly, the least trace of evidence that the "electronic rat" of Shannon, like the natural white rat of Krechevsky, forms any hypotheses. The electronic computer, which works out the proofs of symbolic logic (e.g. theorems of *Principia Mathematica*) and solves the problems of higher mathematics (partial differential equations), thereby displays its capacity for mechanical calculation but not for original thinking in the least degree. This is evident, among other things, from the fact that the computer must always be "programmed" by the scientist; and if a programmer-computer be invented, it will have to be programmed itself to program other computers. It may be true that machines display a type of mechanical learning on the basis of their feedback systems. But learning phenomena, which manifest themselves as the improvement of performance on the basis of past performances, are of two general kinds: rote learning and cognitive learning. While machines may be capable of simulating the former, they are definitely not capable of simulating the latter; and it is the latter kind of learning that is characteristic of man (cf. The theoretical interpretation of learning phenomena at the end of

Chapter 5: II). From a purely logical standpoint, the mechanistic argument, which lies at the base of the identification of the computer and the brain, remains mired in a vicious circle: Without an adequate knowledge of the human brain and its functions, the machine is constructed to "simulate" the brain; then the structure and function of the machine is taken to be a *model of* the cognitive processes in man; the circularity consists, of course, in that nothing is really "discovered" about the nature of the human mind except what the mechanists themselves have built into the machine. It follows that the notion of the "thinking machine," when subjected to a logical and psychological examination, turns out to be one of the commonplace superstitions of contemporary times. This is not, of course, to belittle the mechanical utility of these advanced instruments for "artificial intelligence"; but their value does not lie in serving as instructive models for biological organisms. The examination of the methodological problems connected with the study of the biological and psychological systems, in contrast to the physical systems, will be reserved for later (cf. Chapter 8).

The persistent objective of behaviorism, from Watson (350) to Skinner (321), has been the control and prediction of human behavior. But, since the logical condition of the *control* of phenomena is the *understanding* of their natural laws, it is evident that control without understanding is logically impossible. Therefore, the proper objective of psychology, whatever its applications, must be the understanding of human nature, just as the objective of the other natural sciences is the understanding of nature. However, it appears that the behaviorists, who have learnt their nominalistic interpretation of nature from philosophical positivism, do not really believe that biological organisms (including man) possess an inherent nature susceptible of study. The confession of J. B. Watson, in his popular textbook on behaviorism, to the effect that "structures tell us not one thing about function," and the notion of the "empty-organism," introduced by B. F. Skinner, are to be regarded as parallel expressions of the same undercurrent of anti-naturalism. Both of these hypotheses have been given implicit expression in the behaviorist formula (S—R), which leaves out the "O" altogether. The behavorist conception, accordingly, stands in sharp contrast with the conception of psychological man in the context of European psychology and American functionalism. It follows that behaviorism is devoted to the study of the S—R correlations, that is, the quantitative assessment of the overt and peripheral behavior of organisms, neglecting their central psychological structures and processes.

And if these central factors be the determinant of the overt behavior, as it is implied by the functionalist formula (R=f(S+O)), then the whole class of behavioristic research shall permanently fail to understand (and therefore control) human behavior. Apparently, something very fundamental has gone wrong here; and this, more than anything else, in the judgment of this author, is responsible for the longstanding division of the house of theoretical psychology.

The root of the theoretical limitations of behaviorism is to be traced to the fact that its basic formula (R=f(S)) is incompatible with the facts of evolutionary biology. From the lowest terminus of the phyletic scale to its highest terminus, the noteworthy transformation of species consists of the emergence of novel biological traits, and that these traits, representing biological structures and functions, are qualitative transformations and not merely quantitative complications. Regardless of the means of this evolutionary transformation, or the interlacings and limitations thereof, the fact remains that biological man constitutes a radically evolved and highly superior species relative to the lower animals (cf. Rensch (299) (300) & Dobzhansky (75)). The corresponding psychological dichotomy has been demonstrated by Buytendijk (51), at the University of Utrecht, on the basis of the comparative studies of "lower" and "higher" animals. The critical difference is to be found, at the cognitive level, between the animal conception of the world as an "environment," comprising the immediate context of behavioral interactions between the stimulus and the response, and the human conception of the world as an "objective reality," extending beyond the immediate biosphere. Accordingly, as Buytendijk has observed, the cognitive process in animals, despite their sundry symbolic and semeiotic contents, may be described as the "shadow of cognition" (*l'ombre de la connaissance*); and animal thinking, because of its elementary associative nature, as the "shadow of thinking." But even the simple world of animal cognition lies beyond the theoretical range of behaviorism: For behavioristics studies the mechanisms of animal behavior, in the form of correct or erroneous responses, with respect to its frequency and intensity, as a function of the various schedules of reinforcement, the magnitude of punishment, and the influence of antecedent factors. Thus behaviorism leaves untouched the "fundamental norms of 'psychic' activity and the neural processes which serve as their 'base'" (Buytendijk (51: p. x)). However, when we examine the physiological *and* psychological "basis of behavior," we come to understand the nature of "behavior" in a fundamentally different light than the mechanical assessment made by behaviorism. The intensive analysis of the concept of *behavior* by Buytendijk (53), in his comprehensive study of the processes of human "stance and movement," in relationship with their underlying physiological correlates, has conclusively demonstrated the *organic quality* of behavioral phenomena. These studies, to be described in a later chapter, lead to the conclusion that the concept of "behavior" itself cannot be either described, or explained, in behavioristic terms. In general, the ratio of "reflective responses" to the "reflexive responses" is directly related to the level of the phyletic scale; and, correspondingly, the biological definition of intelligence is formulated in terms of the ratio of the magnitude of the central nervous system to the magnitude of the peripheral nervous system. The logical consequences of the evolutionary hypothesis, which involve continuities as well as divergencies, are evident: Every species represents a given system of structures and functions; and the scope of theories, based upon the observation of a given species must be strictly limited to the same species without universal generalization. But behaviorism, by deriving its theory of human behavior from the observation of the behavior of the white rat, and generally inferring the nature of the higher mental process from the facts of reflexology and operant conditioning, is guilty of the *genetic fallacy*: Namely, the fallacy that functional simplicity at lower levels constitutes the sufficient explanation of morphological complexity at higher levels. As Tinbergen (339: p. 11) has observed: "In spite of the high respect deserved by the interesting work done with rats, one should be a little sceptical of the laboratory rat as a representative of the whole animal kingdom." And, to the extent that every species possesses a distinct biological (and psychological) structure, to that extent structure defines the limits of function, and in the final analysis, indeed far more than functioning tends to modify the form. It may be concluded then that, while the data of behavioristics in themselves constitute a factual contribution to comparative psychology, their theoretical significance remains highly limited. The elementary truths, with which begins Buytendijk's treatise on animal psychology (51: p. 1), remain a ringing indictment of the programme of behaviorism: "A plant flowers in the garden; a spider weaves its cobweb; a bird chirps in a tree; a dog barks in the distance. That is living nature as it immediately appears to everyone... But man wants to know *why* the plant flowers, *why* the spider weaves it cobweb, *why* the bird chirps, *why* the dog barks... The organic world speaks to us of life, and man wants to comprehend this language." The function of science consists, not merely of description and measurement, but of organization and explanation. And should behaviorism continue to insist that the science of psychology consists of nothing but the descriptive study of the gross physical behavior of animals, then it would be logically consistent with the objectives and methods of behaviorism for it to be classified as a branch of ecology rather than a branch of psychology proper. The examination and defence of psychology as a natural science will be reserved for the last chapter.

II. THE GENETIC THEORY OF THINKING

The phenomena of the ontogeny of the operations of thought, experimentally observed and systematically described by genetic psychology, have been reviewed in the preceding chapter. What remains is the construction of a theory for the interpretation and explanation of these phenomena. In the following pages we shall examine the genetic theory of thought processes, or more precisely the genetic theory of the operations of intelligence, and note its consequences.

Intelligence may be described as the potential framework of the patterns of *thought*, that is, intelligence constitutes the faculty of which thinking is the activity. When genetic psychology speaks of the "*psychologie de l'intelligence*" (Piaget (266)), it means the "systematic psycholopy of thinking." In biology, intelligence is described in terms of *adaptation*, the relative ability of various species being considered as a reflection of their comparative intelligence. The genetic theory considers adaptation itself to be a psychological process which represents the synthesis of the divergent processes of *assimilation* and *accomodation*. These two processes are the complementary aspects of an equilibrate relationship between the subject and the environment. In assimilation, environmental experience is reconstructed by the intelligence of the subject; in accomodation, the psychological framework of the subject is modified by environmental experience. In both cases the objective of the change is the attainment of physiological *homeostasis* and psychological *equilibrium*. The function of intelligence consists of the restoration of the equilibrate state by the reconstruction of the old patterns of behavior in the face of new situations. Intelligence sets the *limit* to productive thinking by defining the framework of conceptual construction. In the terminology of the genetic theory, conceptual constructions are *operations*; and thinking consists of the combination of operations. The formation of these operations is determined by the *genetic level* and cognitive *strategy* of the subject. The genetic theory considers the cognitive processes of *differentiation* and *integration* to be complementary aspects of the genetic evolution of operations. Thus the famous "orthogenetic law" (Werner (359)) of gestalt psychology—which states that the genetic evolution of thinking proceeds from a state of elementary grouping to that of progressive differentiation (analysis) and integration (synthesis)—represents the theoretical affinity between the gestalt and the genetic theories. It may also be noted that the "functional" interpretation of thinking reveals a covert affinity between European genetic psychology and American functional psychology. For this reason, Boring (39), in his classic history of psychology, describes Piaget as a "functionalist." While this author will have reservations in considering Piaget a functionalist, either in the classical sense or the contemporary sense, nevertheless it must be admitted that a definite streak of functionalism runs through the genetic psychology. It is not to be attributed to a mere accident that Piaget describes "intelligence" in terms of its operations and its functional adaptation; for genetic psychology consistently maintains the naturalist perspective, and to the extent that functional psychology is based upon naturalism, there is a basic parallelism between the two. However, functionalism in the narrower pragmatic sense, as it was earlier advocated by Claparède (63: especially "*principe de besoin*"), no longer characterizes the School of Geneva.

Our assessment of the genetic theory of thinking will be mainly based upon the researches of the French Phase (especially Piaget (259) (266) (273) and his Collaborators (84) as well as H. Wallon (349)) with comparative references to the German Phase. After examining the concepts of operation and abstraction, the hypotheses of genetic levels and cognitive strategies, and the principle of equilibrium, the theoretical applications of the genetic theory in the areas of pedagogy and psychopathology will be noted. It will be seen that the theoretical consequences of the genetic and gestalt theories, like the conceptual frameworks of the theories themselves, will be complementary.

1. Operation and Interiorization

According to Piaget's theory of intelligence (266), in its strict sense, the contents of thought consist of *operations*. Thinking is described as the process which employs a complex system of operations in the solution of problems. An "operation" (*opération*) may be described as a psychological structure with a constant degree of equilibrium. "An operation is a regulation which is completely reversible in a system which is completely equilibrate" (Piaget (273: p. 37)). Because the operation is an equilibrate structure, it fulfills the logical conditions of equilibrium: combinativity, reversibility, associativity, identity, analyticity (cf. Chapter 2: II).

The concept of "operation" has been defined in terms of the concept of "psychological structure." What is a structure? The genetic theory adopts the gestaltist conception of structure: A psychological structure consists of a set of elements united in a relational configuration displaying an emergent quality. There are two classes of psychological structures: (1) Perceptual structures. (2) Logical structures (operations). The relationship between these two classes of structures is described by a partial isomorphy (cf. Chapter 3: II). Relative to these classes of structures there are two types of operations: (1) Concrete operations—which are applicable to perceptual structures (data of perception). (2) Abstract operations—which involve the analysis and synthesis of logical structures in thought without the aid of the data of perception.

The *grouping* of operations results in operational schemata. In general these schemata may be classified into two categories: (1) Combinatorial schemata—which involve the permutation of operations. Examples of combinatorial operations are: class and class of classes (classification), symmetrical and asymmetrical relations (seriation), logical constants and operators. (2) Proportional schemata—which involve the correlations, ratios, and probabilities of operations. (The description of specific operations is given in Chapter 2: II and Chapter 4: V). In psychological operationism (Piaget), like physical operationism (Bridgman), *concepts* are described as *operations*. But there is a fundamental difference between the two: For physical operationism an operation is a unit of behavior, usually in the form of a physical measurement, and the aggregate of such units constitutes a concept—hence the concept is defined, operationally, as the set of measurement operations corresponding to it. For psychological operationism, in contrast, an operation is a psychological structure attained by the process of interiorization (abstraction).

Operations are formed by the *interiorization* of perceptual and cognitive behavior. The process of interiorization consists of psychological *abstraction*. The hypothesis of abstraction, which has been proposed by Piaget (262) (273), may be sketched here: There are two aspects of perceptual experience: (1) The perception of the properties of the object. (2) The perception of the relationship between a set of objects.

Corresponding to these two aspects of experience, two aspects of abstraction are distinguished: (1) Qualitative abstraction which results in qualitative operations (concepts of natural sciences). (2) Relational abstraction which results in relational operations (especially the concepts of logical and mathematical sciences). The psychological traits of the process of abstraction have been described as follows: (a) Abstraction is made from the coordination of behavior and not merely from the properties of the object; (b) Abstraction is a transition from a less general structure to a more general structure; (c) Abstraction, being the inverse operation of logical multiplication, involves logical subtraction: (total structure) — (specific structure) = (general structure). A Logical analysis of the concept of abstraction will be sketched later (cf. Chapter 7: II).

If abstract operations be psychological structures, and if abstraction be the process by which they are formed, then the following problem persists: What is the epistemological origin of these abstract configurations which we have referred to by the descriptive designation of "operations"? It is well known that classical empiricism has sought to explain the genesis of concepts with reference to sensation and perception; and that logical positivism has referred their formation to the symbolic function of language. Yet, from the standpoint of the empirical evidence provided by genetic psychology, neither perception nor language constitutes the sufficient condition for the ontogeny of the logical operations of thought (cf. Piaget (266)(284)). We have already examined the relationship between perception and conceptual thinking (cf. Chapter 3: II and Chapter 4: V); and we shall return to the examination of the relationship between conceptual thinking and language later (cf. Chapter 6: I). Suffice it to note here that the genetic theory interprets the ontogeny of the elementary operations of thought to be a function of: (i) The genetic factor of genetic biology—and this constitutes the bond between genetic psychology and genetic biology. (ii) The data of perceptual experience. (iii) The anterior structures of the subject (perceptual and conceptual framework). (iv) The autonomic behavior of the subject ranging from simple groupings and coordinations to abstract constructions. (v) The general law of psychological equilibrium. Accordingly, concepts (operations) are neither the product of perception nor are they the byproduct of language; they are subjective constructions that acquire objective structure and function. It may be noted that the insight of American functionalism seventy years ago (1890) is confirmed today by European genetic psychology.

For William James (146–II) had written in his great work on psychology: "I must therefore end this chapter on the genesis of our mental structure by reaffirming my conviction that the socalled experience-philosophy has failed to prove its point. No more, if we take ancestral experiences into account than if we limit ourselves to those of the individual after birth, can we believe that the couplings of terms within the mind are simple copies of corresponding couplings impressed upon it by the environment." Modern American functionalism realizes the fundamental part played by "structure" in all psychological processes. A logical analysis of the concept of structure will be given in Chapter 7 (Analysis of Basic Concepts).

2. *Hypothesis of Genetic Levels*

The phenomena of genetic cosmology have consistently revealed genetic stages and substages in the evolution of the various conceptions of the subject (cf. Chapter 4). The hypothesis of genetic levels was formulated, by Piaget (255) (266) and his collaborators, to explain the phenomena of stages and substages with reference to the psychogenetic level of the subject. Specifically, this hypothesis attempts to explain two things: First, the "homologies" of psychological structures, reflected by corresponding patterns of behavior, at a given age level. Second, the phenomena of "temporal displacements" (*décalage*) between the different stages of the evolution of various conceptions.

According to the hypothesis of genetic levels, the genetic evolution of conceptions is a function of the formation of operations; and the formation of operations is a function of the psychogenetic level of the subject. The homology of operations at a given age level is the product of identical genetic levels; and the temporal displacements between the genesis of various operations is the result of the relativity of anterior structures. In general there are two kinds of "temporal displacements": There are the "horizontal displacements", where an operation cannot be transferred from one context to another at a given psychogenetic level; and there are the "vertical displacements", where two apparently isomorphic operations appear at different genetic levels. There are four genetic levels which mark the main periods in the psychological history of the subject (Piaget (266)):

(1) Genetic Level I: Elementary Behavior (ages 0–2 years). In this socalled "sensori-motor" period the behavior of the subject is characterized by spontaneity, cyclic reactions (repetition), and habit formation. In general, behavior is external and not yet interiorized; but

elementary streaks of intelligence are discernible in this behavior. For example, toward the end of this period, the subject manifests a comprehension of the means-ends coordination; and recognizes the permanence of objects (the subject expects to rediscover the object that is covered before him). Piaget (271), on the basis of extensive observation, has classified the perceptual and cognitive behavior of the subject during Level I into six stages: (i) The stage of reflexes which commences with the genetic factors and marks the beginning of elementary behavior. (ii) The stage of primary habits during which elementary patterns of behavior are formed. (iii) The stage of cyclic reactions which involves the systematic repetition of a behavior pattern originally formed by autonomic creativity or circumstantial chance. (iv) The stage of means-and-ends during which known means are applied toward the achievement of new goals. In contrast to the preceding stage, here the elmentary schemata of behavior are applied in new situations instead of being repeated in identical situations. (v) The stage of trial-and-error during which the subject—instead of simply applying known means to new situations as in the previous stage—experiments with the discovery of new means to achieve the new goal. (vi) The stage of insight in which the subject discovers the new means for achieving the new goal—not by experimentation as in the preceding stage—but by internal reorganization of the problematic situation in imagination (representation). (2) Genetic Level II: Preoperational Thinking (ages 2 to 7-8 years). During this period two main changes take place: First, the systematization and elaboration of elementary schemata. Second, the formation of the symbolic function (language) and the realization of the sign-significate duality. But, in the absence of the operations of thought, thinking primarily consists of imagination (representation). Preoperational thought employs the "preoperational logic" involving paralogical inferences. Piaget has called such inferences "transduction" in contrast to the "deduction" of operational logic. The essential traits of "preoperational logic" are: (i) The representational nature of thinking which involves a group af images. (ii) The associative and subjective nature of "inductive reasoning". (iii) The concrete nature of "deductive reasoning" which considers the particular and neglects the general. Consequently, the subject in this period consistently violates the laws of logical thinking for subjective reasons. And not until the critical age of 7-8 years does the subject display an awareness of contradiction and a propensity to attain consistency in thinking. This intellectual propensity inaugurates logical reflection—if we accept, with

Piaget, Pierre Janet's description (148) of "reflection" as the systematization of beliefs.

(3) Genetic Level III: Concrete Operations (ages 7-8 to 11-12 years). In this period the schemata of behavior are interiorized; and the basic operations of thought are formed through abstraction. But these operations are applied by the subject only to concrete objects (perception). Hence conceptual thought during this period is limited to the *actual* combinations and does not extend to the *possible* combinations. Consequently, concrete operations, in contrast to abstract operations, lack universality.

(4) Genetic Level IV: Abstract Operations (ages 11-12 to 14-15 years). This period is characterized by two main traits: First, the formation of abstract operations and their application to general conceptions. Second, the formation of the logic of classes and relations (propositions) and the concomitant development of hypothetical thinking. These are the material of "abstract thinking" (Level IV) in contrast to "concrete thinking" (Level III). And operation from a distance—which is the classic trait of thinking in contrast to perception—is nothing but abstract thinking.

Henri Wallon (351), the genetic psychologist at the Université de Paris, who has been investigating the processes of psychological evolution relative to the biological modifications of the central nervous system, has constructed a theory of genetic phases. According to this theory there is: First, the vegitative phase (ages 0-3 months) when the digestive process and sleep are predominant over other bodily functions; second, the perceptual phase (ages 3-6 months) when the subject begins to have a perception of the external world; third, the emotive phase (ages 6-12 months) when emotional reactions are formed; fourth the verbal phase (ages 1-3 years) during which the development of language takes place; fifth, the "period of grace" (ages 3-7 years) when manners are formed; sixth, the "age of reason" (beginning at the age of 7 years) which inaugurates the phase of logical reasoning. It may be noted that the results of Wallon's research confirm those of Piaget with respect to the genesis of logical thinking.

For a comparative study of the various theories concerning the nature of genetic levels, the reader may be referred to the systematic table of genetic levels constructed by R. Bergius (32) of the Universität Berlin. This table consists of a comparative analysis of the interpretations of the various psychologists of the German Phase and the French Phase (notably Piaget, Kroh, Bühler, Busemann, Bize) with respect to the chronological order and psychological contents of the various levels.

The hypothesis of genetic levels confronts two special problems: (1) What are the determining factors of the genetic levels? (2) What is the process of transition from a lower genetic level to a higher genetic level? The explanation suggested by the genetic theory is that a given genetic level consists of an integrated system of psychological structures; that the formation of every genetic level has a startingpoint and a termination; and that the lower and higher levels are always integrated such that the anterior structures of the formerare assimilated, in the final structures of the latter. "No structure is ever totally new, but each is bound to generalize such or such form of the abstract operation of the preceding [structure]" (Piaget (273: p. 114)). Recently, E. Höhn (138) of the Universität Tübingen has described the psychological evolution of the mental pattern of the subject in terms of the process of "active structuring" (*Gestaltung*). This conception may be regarded as the synthesis of the two antagonistic conceptions of development which have always been mutually exclusive: Namely, the hypothesis of hereditary determinism and the hypothesis of environmental determinism. It may be noted, further, that the concept of "Gestaltung" in the German Phase constitutes the logical explanation of the concept of structural "assimilation" in the French Phase. The evolution of genetic levels, then, is a continuous process; and their division into periods, on the basis of their traits, is a logical classification. And it is implied further, that in the last analysis, the determinants of a given genetic level are the same as the determinants of the operations of thought: Consisting of the factors of heredity and maturation, anterior psychological structures in any given state, autonomic behavior of the subject (and environmental experience insofar as it serves as the context of autonomic behavior), and the law of equilibrium.

It is instructive to review the correlation between genetic psychology and genetic anatomy, that is, between the embryology of the central nervous system and the psychological evolution of the genetic levels. Anatomical research has established the fact that the physical mass of the brain shows a regressive increase through the years 1–14 and a constant increase through the years 14–25, roughly speaking. This fact, superficially viewed, would appear to constitute an anatomical argument for the hypothesis of genetic levels, since the psychological range of genetic levels extends between 1–15 years. However, it is noteworthy that the maximum increase in the weight of the brain takes place between the ages of 0–7 years (approximately 1000 grams) and a minimum increase takes place between the ages 8–25 years (approximately 250 grams). Thus the mass of the brain at the age of seven is roughly equivalent to four-fifths (80 per cent) of the total mass of the brain at the age of twenty-five. And yet, according to the genetic theory, conceptual thinking does not begin until *after* the age of seven or thereabout. And it would seem remarkable that the period of the *greatest* anatomical growth should correspond to the period of the *least* psychological growth—were it not for the fact that the concept of "anatomical growth" is notoriously amphibolic (mass growth *versus* structural growth). Accordingly this predicament of the genetic history can be relieved by the structural and field theory of modern physiological psychology (cf. Köhler (177) and Lashley (192)).

In any case, there is *no* positive correlation between intelligence and the mass of the brain *but* rather between intelligence and neurological structure of the brain (cf. Rensch (298)). We may conclude then that heredity and maturation—not to speak of evolution—have an effect upon intelligence only to the extent that they determine the structure of the cerebral cortex. The phenomena of "psychological gap", between various species of animals with different scales of maturation, and of the "evolving of traits", as a function of the selective breeding of animals, both involve structural variation. A child reared together with a young chimpanzee, is at first outperformed in intelligence by the monkey, but after the age of 15 months outperforms the monkey (W. N. Kellogg Experiment). Given a representative group of white rats, whose learning behavior describes a typical unimodal frequency curve, it will extensively evolve the traits of "brightness" and "dullness" by selective breeding over several generations, their learning behavior describing a typical bimodal frequency curve (R. C. Tryon Experiment). The extinct species of animals, reproduced recently experimentally through the process of typological breeding by the German biologist, Dr. H. Heck, are the result of a subtraction of traits in a process of "reverse evolution". The concept of "evolution" and "reverse evolution" may be described, from the psychological standpoint, as the process of the structural transformation of the nervous system of the organism.

Before leaving the hypothesis of genetic levels, two critical experiments which have attempted to verify it will be briefly described:

In a four-year longitudinal study Noelting and Inhelder (240) investigated the problem of the "transition" of one genetic level to another (Ref. Dr. Gérald Noelting: "Signification des transitions dans la théorie des stades"—unpublished paper read at the Universität Bonn (1960)). The 20 subjects were divided into 4 age-groups (5, 7, 9, and 12 years) each consisting of 5 members. About 40 problems, involving concrete and abstract operations, were taken at random from past experiments in the areas of space, time, causality, number, conservation, etc. (cf. Chapter 4). These subjects were periodically tested (4 times per year), and a record of the experimental sessions was kept by the tape-recorder. The results of this study confirmed the hypothesis of genetic levels: The transition from one genetic level to another was continuous rather than abrupt. The subjects did not utilize all the available cues at once but only gradually; and they progressed from the stage of correct solution without logical explanation to the stage of correct solution with logical explanation. However, the longitudinal study found that the genetic levels set in about 6 months earlier than the age-levels defined by Piaget. This discrepancy was explained with reference to the quality of the subjects (above average intelligence estimated by school performance) and the possible formation of "learning set".

In an experiment on the ontogeny of logical operations Braine (43), of New York University, subjected the hypothesis of genetic levels to verification in the areas of space and quantity. A nonverbal technique was used in a typical discrimination experiment. A set of wooden constructions were presented to 41 subjects (ages $3\frac{1}{2}$ to 7 years). The independent variables were the shape, size, and order of the stimuli; and the task of the subjects was to respond to the stimuli with reward. The results indicated that: The periods of the genetic levels including the critical 7th-year point, as defined by the hypothesis of genetic levels must be redefined with reference to a time scale two years *earlier*. For example, the subjects of this experiment formed the conception of the principle of transitivity $((A > B) \cdot (B > C) \rightarrow (A > C))$ which is a basic axiom of the logic of measurement, at least two years *before* the minimum age (seven) indicated by Piaget. Braine explains the discrepancy between these results and those of Piaget with reference to the "uncontrolled" variables of language and the history of the subject. It may be pointed out, as Braine has observed, that children may often have conceptions which they cannot adequately express in language; and that the attainment of conceptions is relatively facilitated by structural (nonverbal) methods. An experimental study of the genetic development of the structures of abstract thinking by Welch (355) confirms the above results.

It may be concluded that the hypothesis of genetic levels is to be interpreted in a relative fashion. The periods of the genetic levels are not absolute, but relative to the biological history *as well as* the psychological history of the subject. For, while the former is measured by years, the latter is the product of past experiences. Hence the concept of "intelligence quotient" (Terman) represents the ratio of "mental age" to the "chronological age" (I.Q. = (MA/CA) 100). We have discussed the troublesome problem of the history of the subject before, and shall not speak of it again (cf. Chapter 4: VII). But, granting the relatively of the concept of "genetic level," the "genetic order" of these levels, described by the genetic theory, remains constant.

The phenomenon of genetic levels is closely related to the phenomenon of "periodicity" (*Periodizität*) which has been observed and described in the German Phase (cf. Lehr (336: p. 196f)). Biologists have for long noted that the everyday life of the plants display a certain periodicity in the form of the continuous rythms of activity. Later this concept was applied to the physiology and psychology of organisms, and a number of oscillating phenomena were explained with reference to periodicity. The *biogenetic law* (v. Baer) and the hypothesis of *genetic levels* (Kroh, Piaget, Wallon) may both be regarded as particular aspects of continuous periodicity. In American genetic psychology the concept of periodicity has been given expression in the genetic principles formulated by A. Gesell (102) of Yale University.

3. *Hypothesis of Strategies*

The hypothesis of cognitive strategies is analogous to the hypothesis of perceptual strategies. The four cognitive strategies, in their genetic order, are the following (Piaget (273)):

(1) The first strategy consists of attending to only *one* aspect of a configuration presented to thought. Example: In a problematic situation the subject concentrates on one of two possible alternatives and ignores the other; or in the face of an argument the subject attends only to one of the premises and thus fails to realize that the conclusion logically follows.

(2) The second strategy consists of attending to the *other* of the two aspects of the configuration. In every respect this strategy is a duplication of the first strategy—except that its content is the antithesis of the content of the first strategy.

(3) The third strategy consists of the oscillation of attention between the two aspects of the configuration. The subject displays an awareness

of the multiple aspects, but fails to comprehend the structural unity of this multiplicity. His attention alternates between the several aspects; and he invariably attends to one alternative, at any given moment of time, to the exclusion of others.

(4) The fourth strategy consists of the comprehension of the structural unity of the configuration as a synthesis of its various aspects. This strategy is an equilibrate strategy, with regulations and compensations between its several aspects in view of the total structure.

The terminology of the hypothesis of strategies reflects the assimilation of American psychology by European genetic psychology (cf. The study of thinking by J. S. Bruner and Coworkers (48) of Harvard University). The psychogenetic progress of thought described by the hypothesis of strategies is similar to the progress of structuration described by the gestalt theory: The emergence of a pattern of thought out of a set of piecemeal elements. The logical structure of the hypothesis of strategies reflects the conceptual triad (thesis-antithesis: synthesis) of Hegel, which keeps recurring in the psychological history of ideas and in the history of the natural sciences.

4. *Principle of Equilibrium*

The genetic evolution of psychological structures (operations) is a gradual and continuous process. In addition to the determining factors of psychological evolution, which we have described, there is a "general law" that regulates this process—the principle of equilibrium (*loi de l'équilibre*). This law holds for all psychological processes (perceptual and cognitive) at all genetic levels. It also constitutes the explanatory principle for the fundamental process of adaptation in the organism-environment relationship. Piaget (265–I: p. 39) writes: "One can, in this case, speak without metaphor of a genetic series and of its convergence toward a certain limit, defined by a form of equilibrium, that is to say, by a certain mode of the composition of the synthesis." The principle of equilibrium—which corresponds to the principle of *Prägnanz* in the context of the gestalt theory—will be described in the following (Piaget (273) (278)).

The principle of equilibrium states that: All psychological structures (perceptual and cognitive) tend to approach a maximum degree of equilibrium (constancy and regularity) relative to their genetic levels. The concept of "psychological equilibrium" is analogous to the concepts of "physical equilibrium and "physiological equilibrium". For in physics equilibrium is defined as the coordination of forces within a system in a state of rest; and in physiology it is described as homeostasis (anabolism - catabolism: metabolism). Psychological equilibrium is described as the structural and functional coordination between the whole and the parts of the system. Thus equilibrium is the synthesis of the two extreme states of partism (dominance of the parts and recession of the whole altogether) and wholism (complete dominance of the whole and the recession of the parts). The traits of psychological equilibrium are: (i) The equilibrate state is characterized by *constancy* and *regulation.* The former preserves the stability of the equilibrate state; and the latter, the proactive and retroactive compensations for transformations. (ii) Equilibrium is not a static but a dynamic state; and hence it is also a relative state varying according to the principle of maxima and minima. (iii) The state of equilibrium is a function of these factors: (a) field of equilibrium (elements of equilibrate system); (b) mobility of equilibrium (proximity of elements); (c) permanence of equilibrium (variation of field and preservation of form); (d) displacement of equilibrium (variation of field and variation of form); (e) degree of equilibrium (which is relative to field and mobility and permanence of equilibrium).

The genetic theory maintains a twofold hypothesis concerning the concept of equilibrium (Piaget (273) (278)): (1) To every psychological structure (perceptual and cognitive) there corresponds a specific form of equilibrium. (2) The evolution of psychological structures (perceptual and cognitive) may be considered as the variations of the forms of equilibrium throughout the series of genetic levels. It follows that we may distinguish between the types of equilibrium corresponding to the types of psychological structures: (1) Partial equilibrium — the irreversible equilibrium of perceptual configurations (example: Ø- gestalten). (2) Complete equilibrium – the reversible equilibrium of cognitive operations (example: logical transformations). In the light of this twofold thesis is to be understood the persistent conclusion of the genetic theory (especially in the form stated by Piaget): Namely that logical structures constutite, neither a lifeless extension of *a priori* forms (rationalism), nor a reducible product of perceptual experience (empiricism), nor yet a conventional symbolic system represented by language (neopositivism), but rather the logical forms of equilibrate psychological structures with an empirical history of transformations. Accordingly, the laws of logic (including the groundprinciple of contradiction) are interpreted to represent the particular manifestations of the protolaw of equilibrium. It may be noted that this interpretation of logical thinking is based upon a "structural theory" of logic. And the rudiments of this theory – which both gestalt psychology and genetic psychology presuppose – has been sketched previously (cf. Chapter 2:I).

5. The Genetic Interpretation of Learning

If thinking consists of the combination and the recombination of logical operations, then the problem of the *learning* of these operations, as the derivative of the problem of the nature of thought processes, presents itself. The genetic interpretation of the process of learning, together with the relevant experimental evidence, will be outlined in the following as a supplement to the preceding discussion (For further details cf. Piaget (277) and Collaborators (84: VII– X)).

The genetic interpretation of learning may be compared to the gestalt interpretation in two respects: First, the genetic theory, like the gestalt theory, explains the formation of *association* in terms of the assimilation of the associated elements into a structure. And the transformation of this structure into a logical operation is interpreted to be a function of the degree of its equilibrium (Hence, as K. Lorenz has stated, "What is called a most 'pregnant' form in *Gestaltpsychologie* is objectively that of the mathematically simplest regularity."). Second, the genetic theory, which considers all learning to be a mediate process, rejects the concept of "insight" as an immediate process. However, in the context of gestalt psychology, "insight" is the product of a mediate process of gradual structuration. It appears that the inadequete interpretation of the concept of "insight" by the genetic theory is the result of an oversight: The oversight of the distinction between the two kinds of *gestalten* (Ø-gestalten and Θ-gestalten), one of which is obtained in an immediate way and the other in a mediate way. As a matter of fact, gestalt psychology, in the course of its transition from the "perceptual period" to the "cognitive period", so influenced the genetic psychology that the latter, proceeding independently thereafter, eventually came to rediscover the very concepts which the former, remaining in its orbit, had made its own for two decades.

In the context of the genetic theory two aspects of learning (*apprentissage*) are to be distinguished: (i) "strict learning" which consists of a mediate assimilation in contrast to the immediate assimilation of perception; (ii) "general learning" which consists of a systematic assimilation of a group of "strict learnings". Generally speaking, "learning", when used without qualification, refers to "strict learning". What, then, is the genetic startingpoint of learning? Perceptual experience is the necessary but not the sufficient condition of learning: For learning depends upon the anterior psychological structures as much as (if indeed not more) upon experience. *Experience* accomplishes two things for learning: Firstly, the activation of the immediate anterior structures; and secondly, the awareness of the subject that these structures are insufficient to cope with the experienced situation. As a result the subject will endeavour to construct (learn) a new cognitive structure. Classical empiricism traced the source of logical concepts to perception; classical rationalism considered concepts to have been derived from innate ideas; and logical positivism has interpreted logic as language. The genetic theory, in contrast to these viewpoints, suggests that logical structures are the products of the state of equilibrium of the subject, and that psychological equilibrium is the basic determining factor in the attainment of these structures.

The relationship between the processes of learning and equilibrium may be described as follows. There are four possibilities outlined by Piaget (277): (i) The complete independence of the two processes. (ii) Learning being the necessary but not sufficient condition of equilibrium. (iii) Equilibrium being the necessary but not sufficient condition of learning. (iv) Learning and equilibrium being reciprocally the necessary condition of each other. Piaget suggests that the third alternative is the case. For, since all learning presupposes a set of anterior structures, and since these structures are the product of the state of equilibrium, therefore learning presupposes a relative state of equilibrium. Theoretically, equilibrium is the necessary condition of operations, and anterior operations are the necessary condition of the learning of new operations, therefore equilibrium is the necessary condition of learning. Practically, however, the processes of learning and equilibration are interwoven. For the subject's state of equilibrium partially determines what he learns, and what he learns in turn affects his given state of equilibrium. But it appears that, in the last analysis, it is the law of equilibrium that regulates the laws of learning, rather than the reverse. It is for this reason that genetic psychologists are fond of reversing the "S–R" formula of behaviorism by the epigrammatic pronouncement to the effect that "in the beginning was the response" (*au commencement était la réponse*). However, if we retain the exact meaning of the term "response" in psychology, namely the subject's reaction *to* the stimulus, then obviously there is never any "response" without first there having been a "stimulus". But what the genetic psychologists mean is, of course, that in the beginning was the subject (representing the "response potential"), and that the psychological constitution of "O" is not unilaterally determined by the environment (representing the aggregate of "S") but rather is the product of the genetic process of his natural history.

Three representative experimental studies, which support the genetic interpretation of learning, will be briefly described here:

Experiment I (Operation of Seriation):

The objective of this experiment (Gréco (84 – VII)) was to investigate whether subjects of the advanced preoperational level were able to learn the logical operations of the level of concrete operations. The apparatus consisted of an opaque tube, through which the experimenter passed a set of three colored balls (white, black, red), in direct order (ABC), in inverted order (CBA), and in the order of the inversion of the inversion (ABC) involving a linear rotation of 180 degrees The transformations of seriation were demonstrated and explained to the subjects (ages 4.6 to 5.10) by the experimenter. Two kinds of learning were the result: (i) "Empirical learning" of the operation of inversion of inversion, but no conceptual comprehension of it. (ii) "Conceptual learning" of the operation of inversion of inversion, with some degree of generalization and permanence. It was concluded that experience is the necessary but not the sufficient condition of learning. The fact that some degree of conceptual learning did take place as a function of experience was explained with reference to the isomorphism of perceptual structures and logical operations.

Experiment II (Operation of Classiffication):

In this experiment (Morf (84 – IX)) the learning of the operation of the 'class of classes by subjects of the preoperational level (ages 4–7 years) was studied. The technique consisted of presenting a class of objects (A) which consisted of two subclasses with different colors (B and C): (B+C=A) therefore (A > B) and (A > C). The classification of the objects was demonstrated to the subjects by groupings and comparisons and the active participation of the subjects themselves. The results were: The subjects displayed a certain degree of learning (The ratio of learning-subjects to age-level being: 28% at 4 years, 41% at 5 years, and 46% at 6 years). But this learning was "empirical" rather than "conceptual" in that it did not really involve a comprehension of the operation involved; for, although the subjects solved this particular problem, they were not capable of generalization. It was concluded that the learning of logical operations could not be explained in terms of perceptual experience exclusively for the anterior psychological structures of the subject constitute a determining factor.

Experiment III (Operation of Conservation):

In this experiment (Smedslund (84 – IX)) the learning of the operations of conservation and transitivity of weight was studied. The familiar technique of altering the form of the object while holding its weight constant and conversely was used. The preliminary tests consisted of: (i) Conservation test: The experimenter made various objects out of a given quantity of argil; and the subjects were to judge the comparative weights and give reasons for their judgments. (ii) Transitivity test: A weighing scale and three objects (identical in size and shape but different in color and weight) were placed upon the table; and the task of the subjects was first to judge the relative weights of the objects and subsequently to weigh them on the scale. The subjects (ages 5.5 to 7.6) consisted of a set of experimental groups and two control groups. In the learning exercises that followed the experimenter, by systematic transformations of the objects and weighing, demonstrated to the subjects the operations of the conservation and transitivity of weights. The results indicated that: While the learning of the idea of conservation was extensive, that of the idea of transitivity was sporadic, but there was a positive correlation between the learning of the two ideas. Piaget (259) points out the theoretical conclusion implied by these results: Environmental experience (stimulation and reinforcement) is not a sufficient condition for the learning of an operation; consequently learning must be a function of internal conflict and reorganization, of the displacement of equilibrium and equilibrate compensation.

Let us briefly review the theoretical status of the genetic interpretation of learning. In a recent theoretical study Apostel (17) compared the logical structures of the various theories of learning in American psychology (Hull, Guthrie, Tolman, Harlow) with that of European genetic psychology (Piaget). Apostel argued that no learning theory will insist that learning takes place in the context of a "zero-state" in the organism; but that the necessary primordial elements must be kept at a minimum in the construction of the learning theory. We may not speak of these rudimentary elements as if they were logical structures; for there is no isomorphy, not even a partial isomorphy, between the two. Furthermore, as the various learning theories indicate, the description and explanation of learning phenomena need not necessarily be cast in terms of the logic of classes and relations. That is the core of Apostel's argument. In defense of the genetic theory it may be pointed out that "learning" is an amphibolic concept; and that the theoretical conflict between learning theories may be explained on the basis of a methodological analysis of the concept of "learning".

The theories of learning in modern psychology are generally classified into two categories (cf. Hilgard (134) and Spence (325)): (1) S–R theories (stimulus-response theories). (2) S–S theories (sign-significate theories). The first category comprises the learning theories of classical and methodological behaviorism; and the second, the learning theories of American functionalism, gestalt psychology, and European genetic psychology. From the theoretical standpoint, this cleavage between the learning theories may be explained with reference to three factors: First, the methodological difference which generates a difference in experimental design; second, the observation of a set of phenomena in the context of different experimental designs; third, the formulation of a set of concepts and hypotheses sufficient for the description and explanation of the different phenomena observed. In the light of these three factors the experimental and theoretical discrepancy between learning theories is understandable. The two categories of learning theories correspond to two general types of learning phenomena observed in different methodological contexts: First, there is *rote learning* corresponding to the reflex functions of the lower centers; second, there is *conceptual learning* corresponding to the cognitive functions of the higher centers. Rote learning is the progenitor of a family of habits; and conceptual learning is the winding path that leads to insight. The dichotomy of habit and intelligence, which has been known in psychology since James (146), represents only the other side of the function. And the contemporary philosophical distinction between "knowing-that" (cognition) and "knowing-how" (habit) derives its seeming profundity from its loose usage of the term "knowing". But if psychologists are not to unlearn what they have learnt about learning, they must refrain from using the term "learning" without qualification. To sum up, the conflict between the theories of learning is rooted in the cleavage between their methodology (types of methods) and phenomenology (types of learning). Therefore the theories that explain "conceptual learning" must necessarily have a different set of concepts and hypotheses compared to the theories that are designed to explain "rote learning". And any attempt to *reduce* the S–S theories to S–R theories is logically doomed to failure, because this would involve the impossible reduction of S–S phenomena to S–R phenomena. Phenomena, *as phenomena*, are irreducible: *(loi phénoménologique)*. It is more than a a decade since Tolman (341) discovered that "there is more than one kind of learning"; perhaps it is not too late now to have explained why there are more than one kind of learning theories. And the explanation provided here is conceptually commensurate with the recent research in European psychology: Noteworthy among these is the essay by Van Parreren (347) of the University of Amsterdam, outlining a "synthetic viewpoint", based upon the "principle of stratification", which integrates the various theories of learning by classifying the corresponding cognitive phenomena into the "autonomous" (receptive) and the "intentional" (active) categories respectively.

6. *Genetic Psychology and Psychoanalysis*

The consequences of the genetic theory for both psychopathology and pedagogy are significant: There is the effect of this theory upon the psychoanalytic conception of the history of the subject; and there are the implications of the theory for the process of education. (For example, Aebli (4) of the Université de Genève has written a comprehensive treatise on this subject). In the following pages, we shall first briefly review the pedagogical consequences, and than turn to an examination of the critical relationship between genetic psychology and psychoanalysis.

If it be true that there are levels of psychological development, then the material taught must be geared to the subject's level of comprehension. The classic case of the education of the English philosopher John Stuart Mill—who was made to study the dialogues of Plato at eight, the geometry of Euclid at ten, and the logic of Aristotle at twelve—inspires awe only in those who do not realize that Mill may have read these authors with little conceptual understanding. Philosophers of greater stature and speculative power did not possess scholarship in infancy. The philosophy of the Kindergarten (Froebel) is, if it is anything, that an anterior pattern of experience is necessary for the beginning of elementary education. For the psychological evolution of the child is a continuous process which can be stifled by excessive academic discipline and weakened by the absence of it.

If it be granted that learning consists of the formation, and thinking of the transformation, of psychological structures—then psychology endorses the use of structural methods in all levels of education. For, in the absence of structural methods, rote learning and scatter-thinking will prevail. But such learning and thinking is never constructive and productive. Here again, then, genetic psychology and gestalt psychology meet in agreement. Both suggest that only structural experience is meaningful; and that it alone changes our mental pattern. Thus the reader of these printed words, if he is at all affected by them, will be affected by the pattern of ideas presented here. And in some future time this structural experience will determine in part his reaction to other experiences. There will be figure and ground, abstraction and transposition, transfer and transfer-effect... From a psychological point of view, structure feeds upon structure, and the fly-wheel of structuring runs on the power of psychological assimilation and equilibration.

Let us examine the theoretical applications of genetic psychology to psychopathology.

Academic psychology is never entirely irrelevant to clinical psychology. For it is always easier to demarcate the deviations when the nature of the natural standard itself has been made clearer. And, as Dr. G. Zilboorg has observed, the comparative study of academic psychology might open new avenues for practical research in clinical psychology. The most significant theoretical implication of genetic psychology for psychopathology concerns the constitution of personality.

The psychological history of the subject has a double aspect: The *conative aspect* which consists of the development of biological drives and emotional forces; and the *cognitive aspect* which consists of the evolution of intelligence. Personality weaves its garment out of these two complementary ingredients simultaneously; and the pathology of either constitutes the pathology of the personality as a whole. Further, the dysfunction of either aspect may result in the dysfunction of the other aspect, producing a two-fold pathological personality. Thus, analogous to the double interaction in psychosomatic medicine, there is a double interaction in psychopathology: In some cases the distortion of emotions distorts the thinking; in other cases the variations of pathological thinking generate pathological emotions. The thesis of genetic psychology is that traditional clinical psychology (psychoanalysis), in its concentration upon the conative aspect of personality, has neglected the cognitive aspect (cf. S. Freud (99) and A. Freud (98)). Piaget (269) has noted with "great pity" the negligence of intelligence throughout the genetic history of psychoanalysis. This negligence is particularly striking when we compare the "genetic stages" of psychoanalysis with the "genetic levels" of genetic psychology. And yet, from the standpoint of genetic psychology, there is little empirical evidence for the "stages" and "complexes" of psychoanalysis.

There is a great discrepancy, then, between the two psychological histories reported by psychoanalysis and by genetic psychology. And this discrepancy could not be explained with reference to the double aspect of personality; we could not say that psychoanalysis and genetic psychology tell different tales simply because they describe different phases of the history of the subject. For it is well known that psychoanalysis denies the autonomy and the equal priority of intelligence; and that it has made its notorious business the reduction of the higher mental prosesses to the dark substance of the "unconscious". Genetic psychology, in contrast recognizes the independent reality of both the conative and cognitive aspects. Thus, behind the apparent discrepancy between the accounts of psychoanalysis and genetic psychology, there lies a basic theoretical conflict. But while the hypotheses of genetic psychology are formulated on the basis of objective experimentation, in the tradition of academic psychology, the empirical foundation of psychoanalysis remains vague. The methodological critique to be outlined in the following pertains to the "psychoanalytic theory"; and not the "psychoanalytic technique" (including the technique of dream interpretation) which constitutes a highly valuable contribution of Freud and his school.

(1) Psychoanalytic theory is essentially a monolithic theory which has persistently neglected the basic phenomena of individual differences observed in differential psychology (Terman (334) and Anastasi (14)) and in constitutional psychology (Kretschmer (188) and Sheldon (318)). Psychoanalysis may disdain the elementary anthropometrics of Galton and his followers, but it cannot afford to ignore the facts of constitutional and differentional psychology.

(2) Psychoanalytic theory, despite its hypothesis of the socalled "genetic stages", remains an antigenetic theory: It ignores the autonomous evolution of the cognitive aspect of personality: and its conception of the structure and function of the conative aspect of personality is that of a "miniature adult". Thus psychoanalysis lacks even the simple evolutionary perspective of the well-known "recapitulation theory" (G. S. Hall).

(3) The basic concepts of psychoanalysis—like "thinking" and "cure" —are never clearly described but remain vague. Psychoanalysis has no conception of the processes of thinking as they are comprehended by modern academic psychology. With respect to the concept of cure, psychoanalysis appears to remain essentially in the dark: It describes the external conditions for "cure", but it has no comprehension of the

process of this psychological transformation. And this, we have seen, constitutes a critique of psychoanalysis by gestalt psychology. The history of psychology records that the concepts of "psychic determinism" and the "unconscious"—which psychoanalysis prides itself in having discovered—were introduced into academic psychology by Wilhelm Wundt (1874) and Eduard Hartmann (1875) respectively (if not by Schopenhauer). The history of psychology has recorded the event that Freud, pointing to the complete works of the great Goethe, had said: "That man wrote all that to hide himself." Let this instance be the measure of the suspect species of "introspection" which psychoanalysis, calling itself "depth psychology", practices.

(4) The spell of methodological circularity, which has haunted psychoanalysis throughout its life-history, may be considered the main factor in the estrangement of academic psychology. This circularity is twofold:

(i) When the hypotheses of psychoanalytic theory are not verifiable, this theory excuses itself on the ground that the conditions for their verification have not been fulfilled—*without* being able to point out the comparative differences between confirming and infirming conditions. For example, when the "hypothesis of repression" is not confirmed in a given case, psychoanalysts explain that the repression was too deep to be retrieved. Ernest Nagel (233), in his critique of the logical structure of psychoanalytic theory, has observed that this theory fails to meet the logical requirements of theory construction in the natural sciences: The first being, the deduction of verifiable consequences from the basic hypotheses of the theory; the second, the coordination of the theory with facts at some points by operational definitions. It is understandable, then, why psychoanalytic theory always lends itself to circular defences in the face of counter-evidence.

(ii) The "empirical evidence" of psychoanalytic theory, which is to support the theory, is itself highly colored by the theory. The evidence generally consists of the observation of a non-representative sample of subjects *and* the interpretation of their behavior within the framework of the psychoanalytic theory. Thus the typical orthodox psychoanalyst —like A. Freud and M. Klein in England—studies the "mind" of the child as if it were a static concept, investigates physically and psychologically ill children, and interprets their behavior with reference to the psychology of the model child described by the theory! In the survey of the "objective studies" of the basic concepts of psychoanalysis, which Sears (316) of Stanford University conducted, two theoretical observations were made: The first being that, from the methodological standpoint, psychoanalysis may be described as a "bad science" since the description of its phenomena is systematically distorted by its theoretical preconceptions; the second, that the patients of Freud were a nonrepresentative group whose psychological constitutions were not "characteristic" of American children (cf. Goodenough (112)). In this respect, it may be observed that the psychological differences between the European and American children are deeply rooted in their pedagogical histories. Thus, taking an illustration from everyday life, the harangue of moral indoctrination that the average European child chronically receives leaves American parents amazed; while Europeans are constantly *effaré* by the lagging maturity of the American child and teenager. It is therefore significant that, with regard to the *oedipus complex* and the *electra complex*, an American psychiatrist once remarked to the author to the effect that, while American children may often resent they hardly entertain thoughts of murdering their parents. And, when this writer related the above observation to a Scandinavian psychologist, he begged to disagree, explaining that, were he reared in the Vienna of the late nineteenth century, and educated on the double-faced principle which separates morals from manners, conviction from conformity, he would have not merely entertained murderous thoughts in order to suppress them, but would have probably murdered his parents in actuality. The logic of the argument is clear despite the exaggeration. It is to be noted, then, that the objective of educational psychology in contemporary Europe (as well as in America) is to abolish the duality between morals and manners in the effort to achieve an equilibrium between conviction and cooperation in the conduct of everyday life.

In the light of the foregoing methodological critique are to be understood the sundry critical observations by various psychologists relative to classical psychoanalysis. Thus, Piaget has deplored the utter neglect of the operations of intelligence in the history of the genetic stages as these are described by psychoanalytic theory; Jung has sought to trace the root of the plight of "modern man in search of a soul" to the absence of meaning within, and hence without, the individual who searches for the realization of a realistic pattern of life; Kanner, the leading pediatric psychiatrist in America, has adopted the viewpoint of an eclectic psychiatry; gestalt therapists, examining the essential concept of "cure" in the context of psychoanalysis, have sought to reinterpret it with reference to the concept of "structure"; and lastly, the pragmatic ill effects of psychoanalysis have been reviewed by the American Psychiatric Association (cf. P. Bailey's "Academic Lecture" delivered before the same in 1956).

If we have written a critique of psychoanalysis, it is only because its developmental theory conflicts with the developmental theory of genetic psychology. Of course it is possible to overcriticize psychoanalysis, especially since clinical psychology as a whole, of which it is a part, constitutes the more fragile branch of the nascent science of psychology. However, objectively speaking, our critique only underlines the limited validity of psychoanalysis. The permanent contribution of Freud to psychology remains the clinical description, and a partial explanation, of the irrational aspect of personality. Yet it is not to be forgotten that the trait of irrationality, like other personality traits, is susceptible of relative degrees of combinatorial ratios. To this must be traced the source of the theoretical problem of nomothetic and ideographic dichotomy. As the typological theory of E. Spranger (1928) has demonstrated, the colorful phenomena of differential psychology, which must be taken as the primary data, are to be explained with reference to the patterns of the combinatorial ratios of traits, that is, the psychological types of personalities. In the final analysis, we must look at psychoanalysis in the light of typological analysis. As Karl Menninger has reported, the phantasies of some cases of neurosis may shock even the psychiatrist; but others, we may be sure, are equally shocked by the interpolations of the psychoanalyst. Indeed, the very fact that the doctrine of psychoanalysis, in its orthodox form, "rings true" to some students, more than to others, is in itself psychologically significant.

7. *Critique of the Genetic Theory of Thinking*

Negative and positive criticism both are necessary for the advancement of science—much as the complementary processes of anabolism and catabolism are indispensable for the health of the system. Accordingly, we hope to present in the following pages empirical material, in a comparative fashion, which have theoretical implications for the genetic theory proper. Beginning with a review of certain experimental studies in American and European psychology, which throw some light upon the problems of ontogeny, we shall then make some general observations concerning the limitations of the genetic theory of thinking. However, these comparative notes do not constitute a methodological critique of the School of Geneva which will be reserved for later (cf. Chapter 8: I).

American genetic psychology, which is predominantly functional rather than behavioristic in its approach, is theoretically compatible with European genetic psychology (cf. Goodenough (112) and Gesell (102)). As early as 1926 Carmichael (57) (Smithsonian Institution) studied vertebrates, with respect to their behavioral ontogeny, while experimentally removed from the influence of external stimulation, rejected the hypothesis of autonomy (which considers behavior as a biological function of the organism exclusively) and of heteronomy (which considers behavior as a unilateral function of the environment), and instead maintained the *hypothesis of assimilation* (which represents a synthesis of psychological autonomy and heteronomy). It is noteworthy, relative to this problem, that the recent researches of Gesell (102), concerning the embryology of behavior, have led to the conclusion that the personality of the child consists of a *psychological system* with a genetic dimension. The regulative nature of this system is manifested by its complementary processes of *differentiation* and *integration*, corresponding to the schemata of selective behavior and synthetic behavior respectively. Thus the psychological organism, as an assimilatory system, is a partial determinant of its own structure and function; and, as an adaptive system, it is a partial product of the environment. Here then we have that interaction between autonomy and heteronomy, between the organismic factors and the environmental forces, which progressively gives shape to the psychological history of the organism. Accordingly, Dennis (69), in a paper entitled "Does culture appreciably affect patterns of infant behavior?", has arrived at a negative conclusion, explaining that the traits of infancy are universal and that "culture" simply *overlays* the basic psychological substrata. However, let it not be supposed that this hypothesis constitutes a defence for the neglect of the history of the subject in genetic psychology. For "culture" and the "history of the subject" are not synonymous; the former being one of the factors in the latter. Furthermore, the "universality" of psychogenetic traits, whatever its extent, must not be interpreted as the absence of radical individual differences. We shall return to the relationship between differential psychology and genetic psychology later.

If American functionalism appears to be congenial, with appropriate reservations, to European genetic psychology, American behaviorism is clearly not congenial. The reaction of American psychology to European genetic psychology is parallel to its reaction to gestalt psychology. Classical behaviorists (Watson and Hull) and contemporary behaviorists (Skinner and Spence) alike would reject the theories of genetic psychology on the double-ground of their qualitative methodology and their introspective phenomenology. In a recent monograph Berlyne (36) has constructed a theoretical schema, on the basis of the Hullian system, with the objective of reducing the genetic theory of thinking to the behaviorist theory of learning. Berlyne's argument may be stated as follows: That the phenomena of genetic psychology have rendered the classical doctrine of associationism untenable cannot be gainsaid; but it does not follow that contemporary behaviorism cannot account for these phenomena. For the hypothesis of operations, which constitutes the core of the genetic theory of thinking, can be described in terms of a hierarchical system of a "family of habits". For this purpose three modifications in the system of behaviorism (Hull) are suggested: (i) The concept of representational response (response to stimulus) is to be supplemented by the concept of "transformational response" (response to response). (ii) The concept of stimulus generalization (response to similar stimuli) is to be supplemented by the concept of "response generalization" (response to similar responses). (iii) The concept of external reinforcement (reward) is to be supplemented by the concept of "internal reinforcement" (regulation). The basic concepts of the genetic theory—operation, assimilation, equilibrium—could then be described in behavioral terms by means of the three neobehaviorist concepts respectively. And the addition of these concepts to the basic behaviorist system is not an alteration in principle but in detail, leaving the essentials of the S–R theory unchanged. The critique of Berlyne, written by Piaget (36), essentially consists of the following point: Behaviorism, in translating the concepts of the genetic theory into behavioral concepts, incurs the risk of becoming nonbehavioral. For if "transformations" (operations) are to be external to the organism, then behaviorism has failed in its translation; but if they are to be internal, than behaviorism has merely stated the genetic theory in different words. The whole controversy, Piaget concludes, is but an "experiment on theories". It may be noted, however, that this experiment on theories is deeply rooted in a fundamental problem. For the bone of contention between behaviorism and genetic psychology consists of nothing less than the nature of perceptual and conceptual experience: Whether the organism is a passive recipient of experience or a constructive determinant of experience; whether perception is a process of representation or of construction; whether learning is necessarily by rote or by configuration; whether thinking is always reproductive or also productive? This is the controversial ground upon which gestalt psychology and behaviorism have come into conflict—a conflict which has shed new light upon the path of objective psychology.

In view of the historical affinity between the German Phase and the French Phase, the partial corroboration between the two is to be expected. For, after all, the conceptual development of both phases has been profoundly influenced by the contributions of gestalt psychology. Accordingly, the German Phase interprets the genesis and evolution of cognitive functions in terms of the concepts of *Gestaltung*, *Stufenfolge*, and *Periodizität* (cf. Haseloff (126) and Thomae (336)). The French Phase interprets the same processes in terms of a similar set of concepts: *assimilation* (comprising *structuration*), *stades*, and *périodicité* respectively. It is to be noted, however, that the German concepts, being more general than the French concepts, possess a greater scope of explanation.

Indeed, from the standpoint of gestalt psychology, the French Phase is to be criticized, as we have indicated earlier, for giving an inadequate interpretation to some of the gestaltist concepts.

However, the gestalt trend as a whole, and especially in the context of ethological research, corroborates the results of the French Phase with respect to the natural history of the subject. The pioneering work of Lorenz (206), first at the University of Königsberg and later at the Planck Institute for Comparative Ethology, concerning the phenomena of instinct and releaser mechanisms, is known abroad mainly through the writings of Tinbergen (339). In repeated experimental studies of animals (particularly birds: graylag geese, white grouse, herring gull) Lorenz and Tinbergen have verified that the earliest behavior of these birds involves roughly two processes: (a) The selectivity of the response to the stimuli in the environment; (b) the cognitive function of the stimulus, as a releaser mechanism, for the organism. Thus, newly hatched goslings give a different response to moving objects relative to static objects; the white grouse is afraid of a cross-figure moving one way (resembling a short-necked and long-tailed hawk) but not afraid when moving the other way (resembling a long-necked and short-tailed duck); or the herring gull chick begs for food from a cardboard model of the mother's head with a red dot on the lower mandible but scarcely from a model without a dot (there is even a correlation between the frequency of the begging response and the intensity of the hue of the dot); etc. Further there is the phenomenon of *imprinting*: Once the instinctive response has been released, in a given context of stimulation, then the behavior becomes readily stereotyped, and the animal is incapable of reverting to random behavior. The theoretical consequence of these phenomena, as deduced by Lorenz and Tinbergen, is evident: The animal responds selectively to the environment, because a given stimulus, representing a specific *releaser value*, possesses a unique cognitive meaning to the animal. Consequently, we must go beyond the theory of reflexology, for what this theory calls the "unconditioned reflex" is in the last analysis not really a reflex (at least not in the same sense as the reflexes of the frog which scratches the acid off its belly after its head has been cut off) but the last link in a train of selective processes (*Selektionsvorgang*). And since the precondition of any selective process is the existence of a selective framework, screening the sensations, Lorenz speaks of the "innate forms" (*angeborenen Formen*) of the mentality of organisms. These schemata are instinctive, rather than learned; and the phenomenon of "imprinting" indicates the very absence of reasoning. The experimental study of Hess (133), in the Animal Behavior Laboratory (Chicago), confirms the hypothesis of the innate forms, and their autogenesis, with respect to stereoscopic visual perception (e.g. Chicks, reared in blindfolds, displayed the behavioral coordination, relative to stereoscopic vision, which they had not the opportunity to learn). In a profound sense, the "elementary structures" of genetic psychology may be interpreted to represent such primordial "preconfigurations" (*Vorgestalten*).

From an objective standpoint, the content of the genetic theory of thought processes is susceptible of a twofold critique:

(1) The scope of the genetic theory is limited to the analysis of the *genotype* neglecting the *phenotype*. Two consequences follow from this negligence. The first consequence is the notorious neglect of the hishistory of the subject. The general formula for the psychological system of the phenotype may be written as follows: $O=f\ [(H+E)\ A]$ where H and E designate the hereditary and the environmental factors, respectively, while A represents the factor of psychological "autogenesis" (of which "functional autonomy" and "purposive behavior" are but special manifestations). Recently the generic concept of "bionomogenesis" has been proposed by Rensch (300: p. 321), to represent the synthesis of these various causal factors in the formation of the organism, and it has been defined as follows: "This term means that evolution is a process governed by the development of laws (or regularities) of the living matter, which are true laws (mostly systemic laws) because of the complication of interrelations, which are based, however,

on causal processes." The genetic theory, in neglecting the history of the subject, neglects the E; but we have discussed this recurrent problem previously (cf. Chapter 4: VII). The second consequence is the neglect of the differential aspect of intelligence. Accordingly, the genetic theory appears to be indifferent to the differential psychology of Terman (334) and to the typological psychology of E. Kretschmer (189) and E. Spranger (which are concerned with the types of physique as well as the types of personality) at the University of Tübingen.

(2) The genetic theory, describing the thought processes in terms of a set of *operations*, overlooks the cognitive integration of these operations within the *operator*. Thinking, we are told, consists of the transformation and application of operations, and these involve selectivity and comparison. What is then the means by which the operations of comparing and selecting are effected? Obviously, it cannot consist of *anyone* of the operations themselves, given their specific ranges, and the genetic theory does not illuminate our path here. In effect, the same criticism that the functional theory (James) and the gestalt theory (Köhler) have levelled against the classical doctrines of elementism and associationism must be restated here, *mutatis mutandis*, against the operationism of genetic psychology. For, even though the "operations" of the genetic theory transcend, as configurations, their microscopic elements, they themselves remain nevertheless a set of macroscopic elements. This predicament of genetic psychology results in the paradoxical situation which represents it, objectively viewed, as the psychology of configurational atomism. The neglect of *consciousness* as a unifying function, accordingly, is particularly striking in the context of the genetic psychology, since it includes the *states of consciousness*, as phenomena, in its experimental repertoire (cf. Chapter 4: I). Thus genetic psychology takes consciousness for granted. But then it should not take it so much for granted as not to include it in its theory of thought processes. One might expect that the genetic theory, as an empirical theory, might take note of the "continuity" of thought processes in some form. However, this is not the case; and the concept of "intelligence" does not provide a sufficient solution to the problem. For, in the context of the genetic theory, *intelligence* and *pensée* have an indefinite range, from the preoperations of spontaneous imagination to the operations of logical reasoning; and consequently, it appears that the "consciousness" is here identified with the "contents of consciousness". And, with respect to the "forms" of thought processes, the genetic theory is naturally confined to the ontogeny and transformations of the operations of thought.

The conceptual complementarity of the gestalt theory and the genetic theory has been noted previously. This author shall undertake to contribute a theoretical supplement to these two theories, relative to the morpholcgy of thought processes (especially their types and their continuity), in the following chapter.

CHAPTER 6

PSYCHOLOGY OF THOUGHT PROCESSES
(Continued)

The cognitive revolution in academic psychology, which originated with the structural analysis of perception, extended, at a more abstract level, to the analysis of thought processes. We have examined the psychology of thought processes in the light of the analytic complementarity of the gestalt and the genetic theories. In the present chapter we shall examine the synthetic aspects of thought processes, involving their morphological variations and levels as well as their continuity, for a purely psychological point of view. We shall sketch here, by means of the principles of qualitative analysis, a theoretical interpretation of the empirical facts, relative to the morphology of thought processes, in the context of European psychology. The present chapter is a continuation of the preceding chapter in that, besides the continuity of their subject-matter, our "morphological sketch" constitutes a supplement to the gestalt and the genetic theories. Throughout the groundwork of this morphological analysis, this author has retained the perspective of empirical psychology, and the related epistemological considerations have been relegated to later examination.

Before investigating the morphology of thought processes, it will be necessary to have first clarified the relationship between thought and language. For, if the behaviorist thesis, to the effect that the process of thinking consists of linguistic behavior, be true, then it might be maintained that the linguistic behavior ought to be the proper object of our story. If, however, the configurations and operations of thinking constitute the psychological reality which underlies language, and of which verbal behavior is but a symbolic manifestation, then we should be highly sceptical of the value of the statistical assessment of "verbal responses" for their own sake. We must, then, establish the functional autonomy of thinking relative to speaking, from the experimental as well as theoretical standpoints, before undertaking the investigation of the morphology of thought processes. It will be seen that the gestalt theory as well as the genetic theory maintain the hypothesis that the thought processes are psychologically independent of language. And if this hypothesis be valid, that is, if it be the case that we seldom think with words, then the old problem of *Denkpsychologie*, "What is it that we think with when we think at all?", presents itself again, and cannot be dismissed any longer, even if to be studied in a far different light than before. The search after the solution to this problem, besides the cognitive phenomena of empirical psychology, will lead us to the investigation of the morphology of thought processes.

I. THOUGHT AND LANGUAGE

From the standpoint of psychology the problem of the relationship between thought and language may be stated as follows: Is the ontogeny of thought processes a function of language or is it independent of language? Is language the necessary or sufficient condition for thought processes or is it neither? The thesis of genetic and gestalt psychology is that language is not the sufficient condition for the operations of thought. The phenomena which constitute the evidence for this thesis will be briefly described. The empirical evidence will be followed by a theoretical critique of the doctrine that maintains the identification of thought and language.

The experimental researches of genetic psychology have shown that the evolution of intelligence extends beyond the realm of language. On the one hand, the elementary roots of the operations of thought precede the formation of language; on the other, the formation of language and of the abstract operations of thought are not synchronistic. Pierre Janet (148 – II) speaks of "*l'intelligence avant le langage*". Piaget (266) (303) has observed that children manifest intelligence at the prelinguistic stage; and that the development of their intelligence continues long after the essential completion of language. By the age of 4 the essential formation of language is completed; and yet, logical thinking is not fully developed until the age of 12–14 years.

The investigation of the genesis of elementary logical structures (classification and seriation), by Piaget and Inhelder (284), shows that the usage of words and the knowledge of corresponding ideas are not the same thing. They have observed that children at the preoperational level (ages 4–6 years) employ class-words *without* any comprehension of the concept of class. Whenever children of this genetic level used a class-word like "dog" or "cat", it turned out that they meant by it a particular animal or its image. These subjects displayed a proficiency in language but not a comprehension of the concepts named. These results are complemented by the study of the thought processes of otolaryngeal patients made by Oléron (242) at the University of Paris.

An experimental study of the relationship between logical thinking and language was made by Morf (229) of the University of Geneva. The problem was whether subjects at the level of concrete operations (Level III) could attain abstract operations (Level IV) by means of linguistic learning. The subjects consisted of 119 school children (ages 7–15 years). The logical concepts to be learned were: implication ($p \rightarrow q$), inclusive disjunction (pvq), and exclusive disjunction (pwq). Brief stories, involving these concepts, were presented to the subjects, followed by interrogation. Example: Two hikers, having forgotten to take along supplies, locate an old cabin; there they find some food (condensed milk, canned soup, old meat); they eat them and after an hour become ill. What food made them ill? The concept involved is inclusive disjunction, and the correct solution of the problem requires a comprehension of this concept. The results indicated that these logical concepts were not attained by the subjects prior to Level IV. The majority of the subjects at Level III failed to produce a logical solution to the problem. Instead their solutions were subjective in nature: E.g. "The soup made them ill because they eat too much of it" or " The meat made them ill because it was very old". The linguistic aid which the experimenter gave these subjects—like the analysis of possible hypotheses—resulted either in superficial solutions without valid reasons, or was of no help at all (except by analogy).

Granting the thesis of genetic psychology—that language is not the *sufficient* condition of thinking—the problem remains: Is language the *necessary* condition of thinking? This much is implied by the above studies which show that the roots of intelligence, which is the progenitor of logical thinking, are traceable far into the prelinguistic level. I shall report here the results of an experimental study, which was made by this author, but which was never completed, for reasons of deeper involvement in theoretical psychology. This experimental study, concerning the relationship between thought and language, was essentially a study in gestalt-formation.* The problem was whether subjects at a lower genetic level could attain a logical concept, given its anterior structures, appropriate to a higher genetic level. A problem, which

* Cf. Ash Gobar: "Recherche expérimentale de la gestalt génétique de la pensée infralinguistique", a paper delivered before the annual convention of the Centre d'Épistémologie Génétique (Institut J. J. Rousseau) at the Université de Genève (Spring 1960).

involved the concept of exclusive disjunction (pwq), was presented in the form of a set of brief stories. Example: "A biologist went to a tropic island to study its wildlife; he knew the types of animals living there (A, B, C, etc...); but often came across footprints blurred beyond distinction. What type of animal had left this track behind?" The subjects consisted of 40 school children (ages $7\frac{1}{2}$–$9\frac{1}{2}$ years) accepted on the basis of a screening test (failure to solve the problems presented). They were then divided into two groups: (i) The control group which was given "linguistic aid" (analysis of possible hypotheses *and* the verbal statement of the logical solution). (ii) The experimental group which was taught by a "structural technique" (demonstration of an analogical model whose perceptual configuration was isomorphic with the logical structure of the stories—a disjunctive series of elements implying an effect $(c_1wc_2w\ldots cn)\rightarrow E)$. The results indicated that the structural technique was far more effective, compared to the linguistic aid, in the attainment of the concept (55 per cent of the experimental group learnt the concept compared to the 5 per cent of the control group). The performance of the experimental group could not be attributed to the employment of "interior language", because the overt aid of language did not help the control group. Of all types of linguistic instruction the *analogy* appears to be the most effective: For the analogy represents the invariant of transposition—the same configuration bereft of its former linguistic garb. It appears, then, that language is not the necessary condition of elementary thinking—which is purely structural in nature.

The above result is essentially confirmed by the experimental study of the ontogeny of logical operations by Braine (43) of New York University. After a general survey, Humphrey (142) of the University of Oxford, in his book on the psychology of thinking, concludes that *all* experimental evidence is against the "identification" of thought and language. More significant in this respect are the intensive researches of F. Kainz (155), of the University of Vienna, concerning the phenomenological independence, but pragmatic dependence, of thought and language. In an international symposium on the psychology of thinking and speaking, held in 1954 under the direction of G. Révész (303) of the University of Amsterdam, the majority of participants defended, on various grounds, the thesis that thought is independent of language. It appears that the process of thought can continue without language, as a purely structural process. But, beyond the elementary levels, this structural process acquires a complexity which necessitates codification. As Jørgen Jørgensen (303) of the University of

Copenhagen has observed: Language as a system of codification is indispensable at the advanced levels of thinking; and without it the theoretical inferences of logic and the sciences would become almost impossible. Our discussion may be recapitulated, using the words of Piaget (256: p. 250), as follows: "Thought creates the language and then passes beyond it, but language turns on thought and seeks to imprison it". It may be concluded then that, genetically, language is not the necessary condition for the ontogeny of thought processes; but that, functionally, language is necessary for the operations of thought. However, it would be a gross error to deduce, from the fact that thought and language are functionally interrelated, that these processes are identical psychologically. And the doctrine that maintains the identification of thought and language, defies the recent facts of empirical psychology, and subsists upon a set of suspect assumptions. Since these assumptions are theoretical in nature they call for a logical examination.

The logical analysis of language, as a semeiotic system, reveals three dimensions: (a) The semantic dimension ranging over the reference and meaning of words and propositions; (b) the syntactic dimension over the relations between words and between sentences; (c) the pragmatic dimension extending to the means of transmission. At least thus-far phenomenology (especially Kainz and Mauthner) and neopositivism (Carnap and Morris) are agreed: That the tridimensional analysis of language, whatever the definition of language, represents the convergence of logical and psychological analysis. However, when neopositivism (and behaviorism) go further, and interpret the pure operations of logical thought in terms of linguistic manipulations, than they are also compelled to adopt the conception of language as a "system of signs". But the description of language as a "system of signs" remains a very loose description. For "sign" itself is an ambiguous concept: (i) Sign means a conventional unit of codification (e.g. the *word* "rain" is the sign for the phenomenon of rain). (ii) Sign means a phenomenon correlated with another phenomenon (e.g. the *phenomenon* of dark clouds is the sign for the phenomenon of rain). The logical difference between these two meanings of "sign" lies in that they appertain to different logical levels: The sign as "phenomenon" pertains to the object-level (logical level I); and the sign as "word" pertains to the level of object-language (logical level II) or metalanguage (logical level III). The difference is between *codification* and *correlation*, between convention and discovery. Language then may be described as a system of codification. The loose conception of language as a "system of signs" is guilty of extending the realm of language over the realm of experience. And it is on the basis of this illicit extension that the linguistic theory of thought describes thought processes in terms of verbal processes. It overlooks, of course, that language is a part of cognitive experience, and not experience a part of language. For thinking covers all the essential aspects of conscious experience; and language only represents the codified aspect of thought. H. H. Price (291) of the University of Oxford, in his work on the nature of thinking and experience, has offered a definitive critique of the linguistic theory (A. J. Ayer and C. K. Ogden). Corresponding to the dichotomy of correlation and codification, Professor Price suggests that we distinguish between "sign" (correlation) and "symbol" (codification). Accordingly language would be limited to the system of symbols; and sign-thinking would not at all involve language. And even when we think with symbols, the thought often "overflows" its symbols (e.g. We *look* for the right word passing from symbol to symbol). Whether we describe languages as a "system of codification" or as a "system of symbols" is immaterial—provided we have grasped the proper function and limitation of language. In any case the logical dichotomy which we have sketched will guard us from the loose usage of the term "language" which has become fashionable in contemporary philosophy. It will also spare us from superfluous distinctions: For example the distinction between "*Wortlos Denken* (thought without words) and "*Sprachlos Denken*" (thought without language) and the insistence that, after all the evidence has confirmed the possibility of the former, the latter is nonetheless not possible.

Gestalt psychology and genetic psychology alike confirm the structural nature of thought processes. And if thinking consists of the formation and transformation of psychological structures, then thought is not to be identified with language. Thinking cannot be the product of language, for the logical structure of language (grammar) itself is the product of logical thinking. The very construction of language presupposes the operations of thought. The natural sciences—including psychology—constantly construct new words to fit their new concepts. But the concept, the idea, is always prior to the word. To confuse language and thought is to confuse the sign and the significate. For in the last analysis language is but the changing garment of thought. The sole empirical evidence for the linguistic theory of thought consists of the observations of anthropological sociology (G. Ryle and B. Whorf)

The pet argument runs *from* the structural difference between primitive and civilized languages *to* the conceptual difference between primitive and civilized thought. The thinking of the primitive people of a primitive land has the form it has *because* the structure of its language is what it is. But it is clear that it could be argued with equal logical validity that the primitive language of a primitive people has the pitiable structure it has precisely because of the amorphism of primitive thought. There is, in fact, some evidence to the effect that this is actually the case: Wertheimer (82), in his study of the psychology of primitive thinking, has observed that abstract concepts are generally absent in the thinking operations of the primitive people. Thus the socalled "empirical evidence" of the linguistic theory turns out to be, at best, a case of *petitio principii*; at worst, a case of bad anthropologizing.

However, let us be more hospitable to this doctrine of "language-philosophy"—which aims at nothing less than the reduction of the "higher mental processes" to verbal behavior. Let us—instead of testing this fragile fabric of philosophical philology in the teeth of natural science—grant it its claim. Let us grant that we think *with* words, and that there *is* such a thing as "interior language". But after we have granted this we must face the data of *introspection*: Whenever we think that we think with words, it is not "real" words which we think with, but the *images of words*. It is always the visual and auditory images, of written and spoken words, that get on and off the train of thought. In the last analysis we think, in this case, with images. And if we think with the images of words, we may also think with other species of images; for the process of image-thinking remains the same in both cases. But the varieties of thinking need not be limited to image-thinking. In any case, it is the phantom of the imagist theory of thinking that arises out of the ashes of the linguistic theory of thinking. And for this reversal the shallowness of the linguistic doctrine itself may be blamed. Part of the trouble, at least, is to be attributed to the thoroughgoing negligence of the natural history of language itself by the positivist studies. It is well to distinguish, following Cassirer (60), the stages of the functioning of language, and its psychological transformations, in the course of its natural history: Beginning with the "mimetic phase" (e.g. the representative and onomatopoeic nature of primitive languages), and developing into its secondary "analogical phase" (corresponding to the "physicalist language" and the "picture theory" in the context of positivism), it finally attains its maturity of expression in its "symbolic phase", where the "theoretical language" of science, preserving its word-object reference, is no longer confined to the naming of concrete things but provides a symbolic index to the abstract forms of thought.

If thought processes are essentially independent of linguistic activity, then they have a psychological reality of their own. And the real problem that reemerges is to describe the nature of this psychological reality: What are the thought processes and what forms do they assume? The gestalt theory and the genetic theory have thrown considerable light on the nature of thought processes. Our supplementary study of the morphology of thought processes, in the following pages, shall attempt to provide a partial answer to this problem.

II. MORPHOLOGY OF THOUGHT PROCESSES

The psychological study of the thought processes has been beset by a pair of intertwining obstacles, which, after a protracted course of distortion and concealment, have been at last overcome by contemporary psychology. For, on the one hand, the thought processes were interpreted, in the tradition of classical psychology, to be the epiphenomena of perceptual processes; and, on the other, the thought processes were reduced, by modern behaviorism, to the overt protocols of verbal behavior. Thus, for a time, the study of sense perception and of linguistic symbolism, together, constituted the alternative substitutes for the direct investigation of the thought processes. And the discovery of the psychological duality between perception and thought, as well as between thought and language, despite its historical anticipations (especially in the "process theory" of Wm. James (146) and in the "complex theory" of G. E. Müller (231)), is the result of the recent revolution in cognitive psychology. The essential distinction between the two kinds of psychological configurations (Ø-gestalten and Θ-gestalten) belonging to the different realms of perception and thought respectively, and the distinction between the "concrete operations" and the "abstract operations" of cognition, have been the product of experimental discoveries in the contexts of the gestalt and the genetic schools. There had been, of course, an element of truth contained in the classical theory of thought processes, namely the concept of "abstraction", and this element is to be retained in contemporary psychology, albeit with a phenomenological interpretation. In any case, the net result of the cognitive revolution in psychology has been the theoretical inversion of the classical relationship between thought and perception and between thought and language.

Our examination of the gestalt theory and the genetic theory of thought processes has yielded a set of explanatory concepts: On the one hand, there are the concepts of "*Vorgestalt*", "Θ-gestalt", "inset" (*Einstellung*), "insight" (*Einsicht*), "reorganization" and "recentering", and "*prägnanz*", relative to the transverse analysis of thinking; and on the other, there are the concepts of "grouping", "operation" (*opération*), "assimilation", "genetic levels" (*stades génétiques*), and "equilibrium", relative to the longitudinal analysis of thinking. In the light of critical retrospection, these two theories, by their systematic application of qualitative analysis to psychological phenomena, have effected the revolution in the interpretation of cognitive processes. And even if genetic psychology has derived, in an altered form, some of its basic concepts from gestalt psychology, the longitudinal perspective of the former renders it complementary to the transverse perspective of the latter. The theoretical affinity between the two psychologies, however, goes deeper than mere conceptual transposition, and must be traced to their methodological groundprinciples: Principles which refer to the reality of cognitive processes, as the underlying operations of verbal and averbal behavior, and to their accessibility as well as susceptibility to structural analysis. However, it is their application of the methods of "analytic morphology", which necessarily excludes higher level synthetic integrations, that we encounter in both contexts.

If contemporary psychology has not investigated certain areas of cognitive processes, from a synthetic standpoint, it has nevertheless precipitated a varied record of experimental observations, which reflects the range of the variations of cognitive phenomena, and which constitutes a sufficient empirical basis for the outlines of a synthetic morphology. In the following pages we shall endeavor to sketch the morphology of thought processes, as a propaedeutic contribution, from the synthetic standpoint. However, it is to be stressed that this study may be regarded as original, not in that it introduces new principles of morphological analysis, but only in that it extends that analysis to a neglected aspect of thought processes in psychology. Indeed the history of European psychology represents a longstanding heritage of morphological studies, analytic as well as synthetic, and it is in the context of that background that the configuration of our sketch acquires its prominence and significance. Considered in that light, this study in *synthetic morphology* stands in relief with the *analytic morphology* of the gestalt and the genetic theories, a contrast which renders the former a complementary supplement to the contributions of the latter. Hence, the generic term "morphology", when used in the present context, is bo be understood in the strict sense, being concerned with the types and levels of the phenomena of thought. Accordingly, our analysis shall be confined to the following aspects of thought processes: (1) The morphological types of thought processes; (2) the psychological levels of thought processes; and (3) the functional continuity of thought processes.

Types of Thought Processes

After all the accomplishments of contemporary psychology, with respect to the elucidation of the phenomena of thought processes, the notorious difficulty of a proper definition of *thinking* still persists. The attempt to circumvent this difficulty by adopting a narrow conception of thinking (e.g. "problem solving" in the context of functionalism) does not solve the problem but simply fences it off. Nor does the preservation of an undefined general conception (e.g. the notion of "*pensée*" in the context of genetic psychology) achieves anything but a symbolic generalization. In the following we shall attempt to trace the roots of this difficulty, by means of a psychological analysis of the thought processes, and to seek its solution in a morphological synthesis. And when the results of our investigation shall have demonstrated, that there are but *several* types of thought processes, than it will have been made clear that each type requires a separate definition, and that the integration of these definitions constitutes the synthetic definition of thinking.

The concept of *type* occupies a fundamental place in the methodology of the biological sciences, in general, and especially in morphological studies. Without elucidating the epistemological basis of this concept, here, suffice it to describe the *type* as the integrative representation of an abstract entity which constitutes the converging point for a set of correlated phenomenal traits. These correlated traits, consisting of the essential traits of a group of phenomena (familiarly known as the "family traits"), provide the indices for the diagnosis of the natural type. It may be noted that mere classification does not represent the identification of the type, even though phenomena of the same type may be classified under a given category, since the determination of the type of phenomena is a very different operation from that of their classification. Roughly speaking, while any trait whatever is sufficient for the establishment of the classification, it is logically necessary for the identification of the type to discover *all* the essential traits by means of the structural analysis. (The examination of the methodological and epistemological problems connected with the concept of "type" will be deferred for later (cf. Chapter 10: I).

The phenomena of thought processes, as they have been observed and recorded in experimental psychology, are susceptible of a morphological interpretation, representing four main types of thinking. We shall describe these in the following, in their genetic order, which coincides with their logical order:

(I) The *imagist type*

Psychology is essentially concerned with the problem of form rather than of substance; and we shall refrain from asking here the philosophical question concerning the *material* which images and imagery are made of. The best that psychology can aspire to accomplish is to describe the form of the process of *imagination*, its elements (*images*) and products (*imagery*), and its relationship to the other processes of thought. Beginning with the description of the process of imagination, as the representation and transformation of images, we are led to the analysis of its contents. The primary configurations resulting from perception may be referred to as "images", the recurrence of the same in a different context as "secondary impressions", and the combination and recombination of both as "imagery". Accordingly, imagination may be reproductive (recurrence of the same pattern of images) or productive (reconstruction of a pattern of images from the old image elements). In general, while the "foreimage", as the sign serving to conjure the image, precedes the elementary image, and while the "afterimage", as the recurrence of the impression of the image, follows it, nevertheless both form, together with the original image, the elements of retrospective imagination. Images are not "abstract entities", since the imagination itself is a function of the epistemological coordinates of space and time, and therefore the imagist type of thinking necessarily remains concrete. This type of thinking, to apply the analogical terminology of H. H. Price (291) of Oxford, may be described as "tied thinking", in contrast to the "free thinking" of the conceptual type, for it remains tied to the qualitative texture of the objects of thought. And the phenomenon of the *eidetic type*, studied by H. Klüver (164), constitutes a special case of the imagist type, that is, the case of the constancy of the iconic trace relative to the coordinate of time. The basic problem of imagery, as the combinatorial representation of images, involves the nature of the associative bond: What holds the train of imagery together, that is, what determines that *this* image must follow *that* image rather than any *other*? The familiar answer of classical psychology, in terms of the proactive and retroactive association and the laws thereof, is no longer satisfactory. For, while it was clear that association involved mental elements, it was never explained what the process of association itself consisted of. Accordingly, the concept of "association" is retained in contemporary psychology but with a radical reinterpretation: In the new context, since the images themselves are considered to be configurations, association becomes a process of structural reintegration (Since we have discussed the gestalt theory of association, especially in the form represented by Köhler (172), previously, we shall simply assume it here). It follows that associative integration, like all structural reintegrations, has its own laws which are susceptible of an objective description (The great significance of the analysis of the "train of images" (*Vorstellungsverlauf*) by G. E. Müller (231) consists in having achieved precisely this objective). Consequently, we may still speak of "mental chemistry", as did classical psychology, but meaning thereby the chemistry of psychological compounds rather than of mental elements. Of course, a given configuration itself becomes an "element", in the context of a larger reintegration, but still the fact remains that the ultimate psychological units consist of synthetic configurations.

It is well known that the eidetic imagery of children and of artists, whether pictorial or literary, is distinctive in being striking. The imagination of children, in the absence of the abstract schemata of thought, manifests a spontaneity which is unlimited by a conceptual boundary. Consequently, the spell which is cast upon children by the tales of mystery and imagination, is to be explained with reference to the psychological fact that nascent cognition, ranging between perception and imagination, identifies the objects of these realms with the objects of reality. In the same manner, but at a higher level of aesthetic operation, the imagination of the artist, beginning with the primordial "dionysian oath", at the feet of the vision of the Icon, forever hovers in regions distant from the edifice of logical reasoning.* It is true, some-

* The poetry of Theodore Roethke, the contemporary American poet, constitutes one of the purest manifestations of the imagist type of thinking (The following lines are taken from the "Shape of the Fire" in *Other Poems* by Th. Roethke, courtesy & copyright of Doubleday & Co., New York, 1947):

"Water recedes to the crying of spiders.
An old scow bumps over black rocks.
A cracked pod calls.
Mother me out of here. What more will the bones allow?

times the artist returns to philosophy, like the prodigal son, and blends the imagist and conceptual perspectives in his aesthetic vision: In this exclusive class we may name Goethe, Ibsen, Dostoyevsky, James, Kaffka, Gide, and Hesse. The painstaking perfection with which the disciplined hand of the artist habitually reproduces the form of an object, appears remarkable to the naturalist despite, and perhaps because of, the latter's profounder knowledge of the nature of the same object. Thus while Darwin was a morphologist of the first order, it was Dürer the painter who could lay claim to a better picture of a piece of turf. While William James was the great systematic psychologist, it was Henry James the litterateur who always managed to retain the stream of impressions from persons and places, together with their psychological nuances and interrelationships, which he subsequently wove into the fabric of his psychological novels. How very different are the psychological undercurrents of the notebooks of these two great writers: The one, consistently striving to place the facts of experience into the conceptual and hypothetical frameworks of abstract thought; the other, persistently attempting to observe, to recollect, and to describe, as it were, the aesthetic metamorphosis of events real and imaginary. While Jean-Jacques Rousseau was the author of a philosophy of nature, which portrayed Nature as our only haven in the face of the evils of a decadent civilization, it was Henri Rousseau the painter who could recall and subsequently reproduce the image of nature from the roots of the trees to the subtle colors of the leaves. In the Notebook of this writer is recorded a typical case of photographic memory: The subject might reproduce without difficulty a complex diagram after one short look at it, but the same subject could never bring himself to understand a single page of general philosophy after days of repeated reading. We shall refrain from multiplying these examples any more, and conclude with the statement that the imagist type of thinking *may*

Will the sea give the wind suck? A toad folds into a stone.
These flowers are all fangs. Comfort me, fury.
Wake me, witch, we'll do the dance of rotten sticks.
Shale loosens, Marl reaches into the field.
Small birds pass over water.
Spirit, come near. This is only the edge of whiteness.
I can't laugh at a procession of dogs.
In the hour of ripeness, the tree is barren.
The she-bear mopes under the hill.
Mother, mother, stir from your cave of sorrow."

Etc.... a random series of dissociated but arresting imagery, saturated with authentic eidetic representation, bearing no relation whatever to any abstract logical schema, but clustering together, as it were, by being heavily burdened with their innate emotional significance, and bordering upon aesthetic mysticism.

take place in the absence of, or with a minimum of, the conceptual and hypothetical types of thinking. In general, however, the various types of thought processes go on in the subject in combinations of various proportions.

We shall now turn to the relationship between imagination and emotion and sketch the rudiments of an *eidetic theory of emotions* (cf. Gobar (108)). The imagist type of thinking exercises a pervasive power over the genesis of emotions. For, even if we accept the famous James-Lange theory of emotions, we may still recognize that, in the last analysis, the whole family of emotions feeds upon imagination. According to the James-Lange theory (James (146–II)), the emotion does not precede bodily changes but succeeds them: It is not true that we weep because we are sorry, we scold because we are angry, we run away because we are afraid; but rather, we feel sorry because we have cried, we are angry because we have spoken harshly, we are afraid because we have run off... James described emotion as the "feeling of" bodily changes, and not as the bodily changes themselves. Clearly this theory does not advocate the *reduction* of emotions to psychological states; but only the *correlation* between the two. Those who have rejected the Jamesian theory of physiological reductionism, have themselves failed to offer a better substitute. An attempt has been made by existentialism (J.-P. Sartre), for example, to offer a substitute theory: but even if the Jamesian theory *were* a theory of physiological reductionism (which it decidedly is not), it would be easier to accept that "physiological theory" than the "magic theory" of existentialism! For nothing is gained by calling the process of emotion a "magical" process. The genesis of emotions lies in the structural confusion of the psychological context. Bodily changes, to the extent that they result in the diffusion of energy, give rise to an emotional state. But it is always the *image of* bodily changes that intensifies the emotions. Emotion, once started, feeds upon imagination. We may feel sad and tend to weep; but our sorrow by itself may not be sufficient to make us weep. Then, sitting aside, we observe the train of sorrowful images passing before us—*including* the *image of* our sorry sitting self—and these images will be sufficient to make us weep. And the image of our crying self, which is to follow, will only add to the intensity of our crying. It is a commonplace fact, to which all observant mothers will testify, that the emotional states of children pick up momentum, as it were, as a function of the duration of their crying. The generation of profound emotions in the presence of the work of art, worthy of the name, from the "Winged

Nike" in Greek sculpture to the "Phases of the Night" in contemporary German expressionism, is all too familiar. But aesthetic experience, which generally takes place in the presence of the aesthetic object, would be deprived of the greater portion of its emotional content were the perception of the object to somehow fail to conjure the imagery associated with it. Imagination appears to be the necessary condition of emotion. Given a train of images, the emotions quickly awaken and follow in their terrain. In the final analysis the genesis of laughter and crying alike may be attributed to the formation of an image cycle whose apogee marks the degree of our involvement in the reality of the image world. All careful psychological introspection, direct or indirect, attests to this fact. This writer recalls very well a striking case of associative imagination which he recorded in his "Notebook" immediately after the event: Setting out to accomplish a definite task, the subject was taken aback by the first irrelevant object encountered; the unique pattern of the properties of the object, being associated with a past event, resurrected the vivid image of the latter; the latter, in turn, brought back the successive links in a series of associated images, which then paraded in life-like spontaneity; thus the stream of imagery continued till the consciousness of the present faded out altogether and the once-faint memory of the past became a reality again; and when, at last, the protracted experience of this imaginary reality came to an end, the subject found himself prostrate at the threshold of an old emotional state which prevented, even if time permitted, the return to the original task. Amongst the wealth of literary documents, which at the present time constitute the sole material for the psychology of imagination, it is sufficient to recall the introspective case of Goethe: In his very old age, when the physiological basis for the "coarser emotions" had been modified and the capacity for the "finer emotions" dominated, to use the terminology of Wm. James, nevertheless he was able to involve himself in profound emotions, mainly as a result of sustained retrospection, which rebrought before his vision the familiar train of images from the past.*

* In the beginning of Goethe's literary masterwork, in the symbolic "Dedication," is to be found the most striking manifestation of this phenomenon (The following lines are taken from J. W. v. Goethe: *Faust & Urfaust* (Hg. H. J. Meinerts), Rütten & Loening Vg., Hamburg: cf. "Zueignung"):

"Ihr naht euch wieder, schwankende *Gestalten*,
Die früh sich einst dem trüben Blick gezeigt.
....
Ihr bringt mit euch die *Bilder* froher Tage,
Und manche liebe *Schatten* steigen auf;
Gleich einer alten, *halbverklungnen Sage*
Kommt erste Lieb und Freundschaft mit herauf;

Evidently, the restraining influence of conceptual thinking upon emotions is generally indirect rather than direct. For conceptual thought, only through the interchange of the different trains of imagery, as it were, may result in a different emotional state as a byproduct. As a corollary of our analysis, the intense emotionalism of the primitive peoples may be explained with reference to the perennial absence of conceptual circumspection in their thinking, which allows the imagination to pose before them as the vivid representation of living reality itself. Consequently, from the psychological point of view, it is not a matter of historical contingency that in the primitive sculpture, in striking contrast to the Greek Art, there is never to be found a single instance of the ideal type: All that we find here, in this world of pathos wrought with distortions, and bereft of any trace of the unifying ethos, appears to be a spontaneous symptomatology of the baroque states of primeval emotions. Let us, then, leaving the problem of emotions to rest, for the time being, turn to the problem of the relationship between imagination and conception.

(II) The *conceptual type*

The process of conceptual thinking consists of the formation of general conceptions, that is logical configurations, as a function of the perception of a series of phenomenal objects. A *concept* is to be defined, from the psychological standpoint, as the abstract morphology of a class of concrete images. While classical psychology maintained that abstraction was a purely substractive process, the constructive aspect of this process has been recognized in contemporary psychology. Abstraction is a subtractive process insofar as it consists of the elimination of the peripheral traits, and a constructive process insofar as it consists of the synthesis of the essential traits, of phenomenal objects. (A logical analysis of the concept of *abstraction* will be reserved for later (cf. Chapter 7)). Accordingly, the concept represents the logical structure of the "family traits" of the class of phenomenal objects that fall under it. The process of concept formation may be represented by the following logical schema:

....
Was ich besitze, seh ich wie im Weiten,
Und was verschwand, wird mir zu Wirklichkeiten."

We have cited the German because of the significance of the word *Gestalten* (configurations) in the original text, and its psychological relationship to the aesthetic emotion, which has been altered in the translations: The two classic versions of *Faust*, by the poet B. Taylor and the philosopher W. Kaufmann, despite their literary exellence, have rendered the word as "forms" and "shapes" respectively.

$$\left\{\begin{array}{l} \text{Image}_1: \varnothing(x_a)^f \\ \text{Image}_2: \varnothing(x_b)^f \\ \dots \\ \text{Image}_n: \varnothing(x_n)^f \end{array}\right\} \text{— ((Process of)) ((Abstraction))} \rightarrow \text{Concept}: \varnothing(x)$$

(x designates the "phenomenal object", the *subscript* the aggregate of its peripheral traits, Ø the essential trait, and f the representational frequency of qualitative constancy). It may be noted that "conceptualization and "classification" are essentially different processes: For, while any trait is sufficient for the purpose of classification, this is far from being the case with conceptualization. A naturalist may classify together all the red foxes in the country according to the single trait of the metric length of their tails; but such a classification would remain far from having formed a conception of the red fox as a zoölogical species. The classic method of conceptual definition by genus and difference, extensively used in the biological sciences, may be explained with reference to the psychological principle of abstraction. In a fundamental sense, the whole psychological work of Jean Piaget (266) consists of a study of conceptual thinking from the genetic standpoint. The classic studies of the attainment of concepts by Heidbreder (128) and by Goldstein (110), which have set the pattern for these studies in American psychology, illustrate the process of abstraction within the experimental framework. And this process remains essentially unchanged within the theoretical framework. The gestalt theory and the genetic theory both retain this essential nature of concept formation, but only give it different representations. According to the former, the Θ-gestalt is the product of the process of restructuring; according to the latter, the abstract operation is the product of interiorization.

Conceptual thinking does not take place on a horizontal psychological plane. There are *levels* of concepts, and they may be briefly described here. The concept has an *intension* and an *extension*; the former consisting of its logical structure, and the latter of the totality of particular cases that fall under it. These two aspects of the concept are reflected by the two phases of the meaning of the concept, connotation and denotation, respectively. Generally speaking, the higher the level of a concept the more abstract its intension. First level concepts are at the logical level I, for their extension consists of the class of concrete objects (images) at the logical level O. Second level concepts, whose extensions consist of first level concepts, are at the logical level II. Third level concepts have second level concepts for their extension and they are at logical level III; and so forth. The image of a cocker-spaniel, the concept of the dog, the concept of the quadruped animal, and the concept of the vertebrate animal may follow each other with successive degrees of abstraction.

Insight in conceptual thinking consists of the ready apprehension of the general structure in a series of particular cases. It was on the basis of the faculty of conceptual insight that William James defined "genius", namely, as the ability to see the unity of the *same* in the complex multiplicity of the *different*. Ask a good natural scientist to describe his impressions of the life and culture of a primitive island, and he will typically begin by describing a set of general conceptions and then illustrating them by the analysis of some representative specific cases; in contrast ask a travelling salesman for the same, and all that could be obtained from him would be an endless narration of specific episodes, which may be colorful and entertaining enough, but remain at best an aggregate of incomplete and unrelated data. It is one of the special characteristics of conceptual thought, that the knowledge of the intension of a concept does not require the knowledge of the totality of its extension range. We can have, fortunately, a valid conception of a given species of animal, on the bare basis of the inspection of a representative sample of cases, without being required to shake hands with every existing specimen of the abominable species. Hence the peculiar power of abstract thought, which enables it to engage in diverse operations from a great distance. Conception, being a remote process, transcends the limited framework of perception, which is always a proximate process. In this respect we may recall the insightful statement of Kant to the effect that "thoughts (concepts) without content (images) are empty, percepts without concepts are blind". It may be observed only that concepts, taken by themselves, are not entirely nothing for they possess a logical structure. Roughly speaking, the "representation" and "operation" of the genetic theory (Piaget), and the "reproductive thinking" and "productive thinking" of the gestalt theory (Wertheimer), correspond to our imagist type and conceptual type respectively. In any case, it is by means of conceptual thought that we are able to make the transition from the image of a past perceptual experience to the image of a future one; or that we can systematically relate and connect our present perceptions beyond the meagre filiation of spontaneous association; or, in short, that we are able to perform, however perfunctorily, a "mental experiment". Conceptual thought, then, may be regarded as the theoretical medium for the organization of our perceptual experiences. Without this theoretical medium all systematic knowledge, especially natural science and philosophy, would become impossible. For the main step in the methodology of natural science, following that of observation, is classification; and the logic of classes, which permeates all the classificatory schemata of science, is the product of the conceptual type of thinking.

The concept of "abstraction", which has been presupposed in our description of concept formation, will be analyzed separately (cf. Chapter 7: II); and a critique of the doctrine that implies the reduction of concepts to percepts (operationism) will be reserved for a later context (cf. Chapter 8).

(III) The *hypothetical type*

The process of hypothetical thinking consists of the formation of hypotheses, which involves the abstract operation of logical combination and recombination of concepts, resulting in combinatorial intensions and conditional references. Accordingly, the process of concept formation constitutes the psychological precondition of the process of hypothetical reasoning. It may be noted that the empirical evidence of genetic psychology, to the effect that the formation of the "logic of classes" is genetically prior to that of the "logic of propositions", confirms our generalization. The prototype of the hypothesis, represented by the conditional proposition, takes the following form: Since *this* is the precondition of *that*, then if this *were* the case that *would* be the case; or, in other cases, if this *were to be* the case then that *must have been* the case. The hypothetical type of thinking is to be differentiated from the imagist type in two basic respects: In the first place, the elements of the former (concepts) reside at a higher level of abstraction than those of the latter (images); and, in the second place, the nature of the relationships that obtain between the two sets of elements, namely logical implication and associative implication respectively, are to be distinguished. Associative implication is a subjective relation whose negation does not involve any contradiction; logical implication, in contrast, is an objective relation whose negation does involve contradiction.

Psychologically viewed, every problematic situation presents a structural incompleteness; and the function of the hypothesis consists in filling the gap, so to speak, and generating a good configuration thereby. And since the solution of every problem, however trivial, requires the formation of an hypothesis, hypothetical thinking appears to be the necessary condition of all problem solving.* The logical schema for the verification of hypotheses may be represented as follows:

Protocol hypothesis: Given two phenomena, described by the propositions p and q respectively, then p is the necessary and sufficient condition of q.

	Positive	Negative
Confirming Cases	When p is the case then q is the case. $(p) \rightarrow (q)$	When q is not the case then p is not the case. $(-q) \rightarrow (-p)$
Infirming Cases	p is the case and q is not the case. $(p) \cdot (-q)$	p is not the case and q is the case. $(-p) \cdot (q)$

Starting with such elementary logical beginnings, hypothetical thinking ascends to the highest levels of abstract reflection. Corresponding to the levels of the concepts, there are hierarchies of hypotheses. A first level hypothesis, whose terms are concepts (of any level), lies at the lowest logical level. A second level hypothesis has for its terms, not concepts, but first level hypotheses whose terms are concepts. The terms of a third level hypothesis would then consist of second level hypotheses; and so forth. And the concepts of *law* and *mother-law* (*Urgesetz*), in the context of the natural sciences, essentially represent universally verified hypotheses of lower and higher levels.

The relationship of the conceptual and hypothetical types of thought processes may be described as that of logical complementarity. While conceptual thinking ranges from percepts to concepts, hypothetical thinking ranges from concepts to hypotheses. While conceptual thinking begins with the particular case and terminates with the general idea, hypothetical thinking contemplates the patterns of general ideas and the interrelationships thereof. Concepts provide an answer to the

* John Dewey (72), in his psychological work entitled *How we Think* (1933), has offered an interpretation of "reflective thinking" in terms of problem-solving. His description of the five functions of hypothetical thinking, which has acquired the status of a classic model, is summarized as follows: (a) primary suggestions, (b) formulation of the problem, (c) formulation of an hypothesis (leading idea), (d) hypothetical reasoning (deduction of the consequences of the hypothesis), and (e) verification of the hypothesis (physical experiment or mental experiment). The only thing that we would like to note here is that Dewey's theory of "reflective thinking" is essentially a theory of *hypothetical thinking*, and not a theory of *thinking in general* as it has been generally taken to be by contemporary followers of pragmatism. And, taken for what it is, rather than for what it is essentially not, the great value of this theory as well as its great limitation both will be justly recognized. For our conception of "how we think" naturally has far-reaching psychological and philosophical implications.

what problems, hypotheses to the *why* problems. The logical function of the one is conceptual classification; of the other, hypothetical explanation. Without hypotheses, concepts would remain scattered; and without concepts, hypotheses would remain empty.

The history of science would have been in an impoverished state indeed were it not for the power of hypothetical thought. And if the notion of "trial-and-error", fashionable today, means the absence of hypotheses, then it is little more than the "method of stupidity" to use the expression of Klüver. The golden age of science and philosophy in Ancient Greece may be explained, from the standpoint of psychology, mainly with reference to the prodigious faculty of Greek thinkers for abstract reflection. The dialectical method of Plato and the classic logic of Aristotle were essentially theoretical models for conceptual and hypothetical thinking. And the case of modern science is not basically different. Without theoretical hypotheses there would be neither systematic observation nor critical experimentation; and without experimentation and observation no natural laws would be discovered by science. The science of logic itself, with its special relationship to the methodology of natural science, would have been neigh impossible without the capacity of reflective thought to contemplate the abstract forms of itself. And if there be any significance in the recognition of the psychological reality of thought processes, then how superficial appears the commonplace opinion, to the effect that the advancement of science consists of the progessive refinement of the language of science, an opinion which sadly mistakes symptomatology for etiology.

There are various psychological mechanisms involved in the process of hypothetical thinking. There is the *reorganization* of the problematic situation (Duncker (78)), the role of *direction* in the formation of hypotheses (Maier (213)), the set of probable *strategies* employed by the subject (Bruner (48)), the *insight* into the problematic situation and the formulation of the valid hypothesis (Köhler (173) and Wertheimer (364)), and the function of organismic factors like the *set* in hypothetical thinking in general (Harlow (122)) and Luchins (207) and Van de Geer (344)). Since we have had the occasion to discuss these mechanisms, among others, elsewhere in this work, especially in the context of the gestalt theory of thinking, we shall say nothing more about them here.

(IV) The *speculative type*

The process of *speculation* generally consists of the construction of a theoretical system. A theoretical system consists of a set of interrelated concepts and hypotheses. Consequently, conceptual thinking and hypothetical thinking both constitute the preconditions of speculative thinking; since, without the former, the latter would not take place. In general it may be said that the conceptual and hypothetical types are genetically and epistemologically prior to the speculative type. Psychologically, however, the boundary between the speculative thinking and the higher levels of conceptual and hypothetical thinking is dense rather than discrete. This boundary may be thought of as a two-colored network of interwoven patterns rather than as a straight borderline. There are two reasons for this structural feature of thought processes: First, the continuity of thought processes which, it will be seen, is a pervasive phenomenon; second, the speculative type of thinking itself involves various levels of abstraction. The lowest level of the speculative type may commence at a higher level than the lowest level of the conceptual and hypothetical types; and the higher levels of the former may transcend the scope of the most general concepts and hypotheses. Precisely stated, there are levels of theories representing the levels of the speculative type respectively. A first level theory consists of the integration of first level concepts and hypotheses; a second level theory, of the integration of second level concepts and hypotheses; and so forth. The speculative type, then, like the conceptual and hypothetical types, displays the phenomenon of levels; and this phenomenon constitutes a morphological affinity between these various forms of abstract thought.

Our theory, concerning the morphological interrelationship of the various types of thought processes, throws light upon a phenomenon of speculative thought which has received little attention and hardly any explanation in psychological science. We shall give it the descriptive name of the *phenomenon of psychosynthesis*. Psychosynthesis has two complementary aspects: The first aspect consists of the assimilation of past psychological phases; and the second aspect, of the synthesis of a transcendent phase on the basis of the past phases. The psychological evolution of both aspects may display the periodicity which characterizes the biological and psychological processes in general. Accordingly, the general *law of psychosynthesis* may be stated as follows: In the long run, the thought processes display a periodic integration and reintegration, which consists of the assimilation of past cognitive phases toward the synthesis of a transcendent phase, such that the latter represents a higher configuration which preserves in itself the elements of the former. Had classical psychologists (notably Wundt (372) and

Høffding (140)), who had in fact discovered the regularity described by this law, attempted to verify it by experimentation, they would have readily seen its pervasive relevance to the other phenomena of "mental chemistry". The various experimental phenomena of genetic psychology and of gestalt psychology, which represent the processes of the evolution of genetic stages and of progressive structuration, may be interpreted to be the recurrent manifestations of the general law of psychosynthesis. It is in this light that the recent hypothesis of strategies (Piaget), in the context of the genetic theory, is to be understood. In the same light is to be interpreted the productive solutions to the classes of approach-approach and avoidance-avoidance conflicts in the learning situations of everyday life. Again, at an abstract level, the law of psychosynthesis provides a purely psychological explanation for the logical principle of the dialectic triad of Hegel (thesis+antithesis→synthesis). And the theoretical relationship between the biogenetic law (von Baer) and the law of psychosynthesis may be described as that of explanatory complementarity. The biogenetic law, by describing all ontogeny as an abbreviated phylogeny, provides an explanation for the *reproductive aspect* of thought processes; the law of psychosynthesis, describing the evolution of speculative thinking, provides an explanation for the *productive aspect* of thought processes. The classic distinction between reproductive and productive thinking, between concrete and abstract thinking, has been made by the gestalt theory (cf. Wertheimer (364) and Köhler (173)). Likewise the concepts of assimilation, synthesis (integration), and periodicity have been described by the gestalt theory and the genetic theory of thinking (cf. Chapter 5: I& II). We shall therefore refrain from giving an analysis of these concepts here.

The main consequence of the law of psychosynthesis for the "psychology of science" may be briefly stated: A thorough knowledge of the history of scientific and philosophical ideas is the necessary condition of all great theoretical discovery. Without a comprehensive assimilation of the ideas of the past, the attainment of a revolutionary synthesis would be impossible. Ignorance of intellectual history may not merely involve the thinker in the sorry plight of repetition but will also eventually lead to the decline of academic standards. There are thinkers in the contemporary scene, who still maintain the doctrines of a hundred years ago; but they would have not maintained these, had they known of their classic repudiations in history. The history of science and of philosophy stands as the immortal witness of the impact of the ideas of the past upon the ideas of the future. It would indeed be hard to imagine that the theoretical system of Darwin would have been constructed without the conflicting theories of Buffon and Lamarck; of Newton without Kepler and Copernicus; of Kant without Leibniz and Hume; of James without Wundt and Renouvier. It would be hard to imagine that modern science would have progressed very far without ancient science; or modern philosophy without ancient Greek philosophy. We may refrain from going so far as to say, with Whitehead, that all philosophy consists of a series of footnotes to the philosophy of Plato; but with little hesitation we shall say, paraphrasing Hegel, that in order to become a philosopher one must first havc been a Platonist. Even the history of the fine arts supplies us with abundant cases of gifted artists whose creative careers have described the characteristic pattern of the successive assumption and transition of the various aesthetic phases. The first condition of creative thinking consists of having thought the thoughts of past thinkers; the second, the insight to achieve a critical synthesis inaugurating a new perspective. The antithesis of speculative thinking is dogmatic thinking, a pathological habit of thought which leaves the thought strong enough to assimilate one given psychological phase but weak enough never to achieve a synthesis of several phases. It follows that the doctrine of historicism, whose main objective is to trace the source of our most advanced modern ideas to the cave inscriptions of primitive man (who could light a simple fire with great difficulty), never provides a sufficient explanation of the rise of science. This is not to minimize the role of the *Zeitgeist* as a factor of historical determinism; but, without the *originality* of the thinker, the intellectual *Zeitgeist* would wane like a botanical garden without a gardener.

If our hypothesis, to the effect that the other types of thought processes are psychologically prior to the speculative type, be valid, then it follows that subjects with a high potential for the latter type must also display a potential for the former types. There is some evidence in the history of philosophy and of science that this in fact happens often to be the case. For, on the one hand, we have documentary evidence that the systematic philosophers have demonstrated their ability, in relative degrees to be sure, in the various areas of the sciences: E.g. Plato, Descartes, and Spinoza were geometers; Aristotle, Locke, Kant, and James were natural scientists; Leibniz, Husserl, and Whitehead were mathematicians; Bergson, Cassirer, and Hartmann were profoundly learned in the biological sciences. In the varied literature of psychology, the analysis of the relationship between the types of thinking remains absent, unless it is to be traced in the sundry observations of

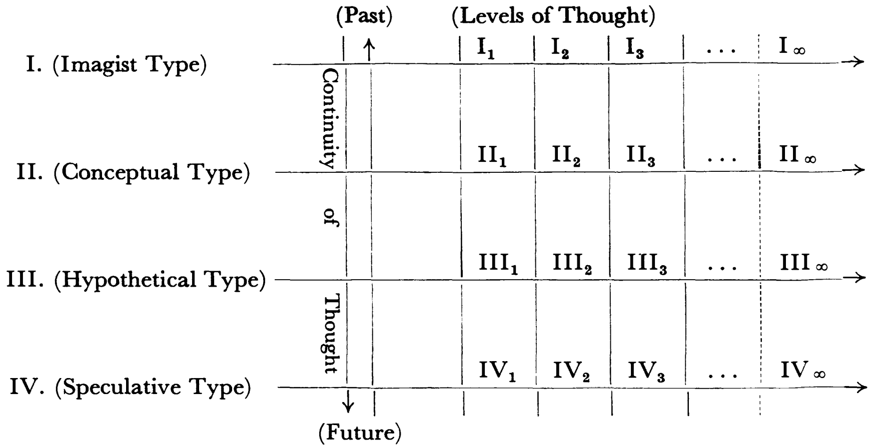
Wm. James (146) and H. Høffding (140). James (146–II: p. 361) writes: "According to our view, there are two stages in reasoned thought, one where similarity merely *operates* to call up cognate thoughts, and another farther stage, where the bond of identity between the cognate thoughts is *noticed*; so minds of genius may be divided into two main sorts, those who notice the bond and those who merely obey it". It may be observed that, based upon this general dichotomy, each plane of thinking is in turn divided into two levels of generality. Thus, on the other hand, the philosophical thinkers have often exerted a pervasive influence upon the researches of the natural scientists: It is well known that the ideas of Plato influenced the geometrical constructions of Euclid; that the logic of Aristotle influenced the systematic botany of Linnaeus; that the "Naturphilosophie" of Schelling influenced the research of Oersted in physics; that the ideas of Schopenhauer influenced the psychoanalytic theory of Freud; that the dialectic logic of Hegel reigns over the contemporary Soviet science; that the critical epistemology of Kant has influenced the views of the contemporary physicist Weizsäcker; and so forth. We shall refrain from referring to specific cases in the history of litarature where influence of the speculative type upon the imagist type is far more pervasive. Suffice it to observe that the capacity for colorful imagination in the abstract thinker is nothing surprising. In a recent study of the psychology of scientists, Anne Roe reports that she was "floored" by the introspective observation of a biologist concerning his thought processes. The biologist, a specialist in the evolution of plants, had described the imagery associated with his general conception of the evolution of plant life: A general picture of the forest containing the various trees and shrubs, together with the underlying geological strata of the earth, undergoing a pervasive metamorphosis through the ages of evolutionary time. This author, the logical corollary of whose theory this very phenomenon is, can hardly find it surprising, especially since his own introspective observation confirms it. And the differential responses of scientists and artists to the Rorschach Test and the Thematic Apperception Test may be interpreted as indicating the combinations of the types of thinking in various ratios, rather than the complete absence of any type, so that the dominant type is manifested with the greatest frequency. Accordingly, the four "types" of thinking described by F. C. Bartlett (25) as a result of his experimental and social research at Cambridge University —namely, the formal, the experimental, the adventurous, and the artistic, respectively—may be regarded as the description of the propensities of the various professional thinkers rather than the description of the morphology of thought processes. For, while this classification bears a faint affinity to the components of our typology, the former remains an arbitrary classification from the standpoint of the latter. Thus, for example, the distinction between "formal thinking" and "experimental thinking" remains inadequate since both of these involve the conceptual type and the hypothetical type alike; and the same holds for the rest. In these respects, then, our morphological analysis of thought processes has gone beyond the conventional classifications.

As the highest form of abstract thinking, speculative thinking performs two general functions within science. In the first place, it engages in the construction of theories within science; in the second place, it explores the distant horizons of science. In the faint light of the speculative theory, science at least finds the *direction* in which it may formulate the hypotheses to be verified by experimentation. It is the speculative type of thinking that differentiates the theoretician from the statistician in the last analysis; the experimentalist, manipulating hypotheses and calculators simultaneously, occupies an intermediate position between the two. And it must be remembered, in the interest of science, that while science will surely starve without facts in will also surely suffocate without theories. For an examination of the structure and function of theories the reader is referred to Chapter 8 (Methodological Framework of Psychology).*

The Levels of Thought Processes

The psychological evidence for the levels of thought processes consists of two sets of parallel phenomena: (1) The phenomena of levels within the various types of thinking. For, as we have seen, there are images and images-of-images (afterimages and recurrent images), there are lower level and higher level concepts, and there are hypothesis and metahypotheses. In all these cases, the thought processes, which ascend progressively to higher intensional levels, represent increasing

* *Note.*—In the light of the above observations a reassessment of the two antagonistic propensities of modern science must be made. For the philosophical distinction between the "tough-minded" and the "tender-minded," originally made by James (147), has been outworn by consistent misuse. It has been variously used by positivists against idealists, by behaviorists against gestaltists, and by fact-collectors against theory-builders. It is overlooked that, if it requires a certain degree of skill and perseverance to collect reliable data, it requires a greater degree of skill and power to construct a reasonable theory. Accordingly a descriptive nomenclature is suggested by this writer: The *statistical-minded* and the *speculative-minded*, corresponding to the data-collector and the theory-builder, respectively. It is understood that these descriptions refer to the prototypes, and that many scientists represent a combination of these traits.



Graphic representation of the morphology of thought processes.

degrees of generality (*Allgemeinheitsgraden*). (2) The phenomena of the levels of awareness within consciousness in general: There is the awareness of the object, the awareness of the awareness of the object,... ad infinitum. Accordingly, the hypothesis of the *levels of thought* may be stated as follows: The thought processes have two complementary dimensions, the horizontal dimension of *prehension* and the vertical dimension of *reflection*, the latter involving multiple levels of transcendent reference. "Prehension" may be described as the cognitive awareness of the object by the subject. Thus, primary perception as well as primary conception, both of which involve the awareness of the object (concrete and abstract), constitute the two variations of prehension. Similarly, perception and apperception, then, are to be regarded as special cases of "prehension" and "apprehension", respectively. However, "reflection" may be described as the transcendental level of prehension, since it always involves the superior awareness of inferior awareness. The psychological levels of thought processes may be represented by the following outline:

Level I – Prehension:
Awareness of the object.
Level II – Apprehension:
Awareness of the awareness-of-object.
Level III – Reflection (I):
Awareness of the awareness-of the awareness-of-object.

Level IV – Reflection (II):
Awareness of the awareness-of the awareness-of the awareness-of-object.
Level ∞ -the infinite degrees of awareness.

It may be noted that, as we ascend the levels of consciousness, the awareness becomes relatively more pervasive; as we descend, relatively less pervasive. For a first-level awareness is always an awareness *of something*; while a second level awareness is of the *class of* first-level awarenesses;and so forth. In the light of the above hypothesis, that apparently strange phenonenon of "setting the mind", as if it were a timer, to perform the function of the alarm clock, is no trivial accident, for it may now be explained with reference to the levels of attention. In setting the mind, to wake us up from sleep at a certain hour of the morning, the first-level attentions are turned off, as it were, so that we might sleep, and a higher level attention is alerted to keep guard of the general passage of time. Even in waking hours, the regular ticking of the clock often ceases to be heard, the first-level attention being held at bay elsewhere, while the higher level awareness still retains a sense of the duration of time.

If the hypothesis of the levels of thought processes be valid, then they must manifest themselves, not merely in the various types of thinking, but also in their precipitated history. That there are levels of memory is a fact established by introspective experimentation. (In this respect our study is corroborated by the recent investigation of the structural variations of memory, as a function of the generalization gradients (*Allgemeinheitsgraden*) of the image, by Brengelmann (44)). When the distinct image of an object returns from the recent past, or the faint image of an object is conjured from the distant past, we have a memory of that object together with the events associated with it. However, there are times when the faint image of the object returns from the remote past *together* with the precipitated memories of the previous recollections of the same object. Thus memories feed, not upon events alone, but upon past memories. And if there be any difficulty in getting away from the past, it lies, not so much in forgetting the objects and events themselves, but in the inextricable process of shaking off the memories of our (recurrent) memories. There is an age-old bit of wisdom in psychopathology, to the effect that the subject, who hopes to effect a change in his personality by changing his environment, is deceiving himself. We are not merely "walking bundles of habits", to borrow the phrase of James, but also we are ancient storehouses of memories. Our psychological well-being consists, if in anything, in the transformation of our habits and in the reorganization of our memories into equilibrate configurations.

The Continuity of Thought Processes

The hypothesis of the continuity of thought processes may be stated as follows: The thought processes, which tend to remain relatively discrete at the lower levels, approach continuity at the higher levels. The psychological evidence for this hypothesis consists of two sets of phenomena. Firstly, the genetic interrelationship of the various types of thought processes: Namely, the imagist type being the psychological precondition of the conceptual type, the latter of the hypothetical type, and this last being in turn the precondition of the speculative type. Secondly, the phenomena of the levels of thought processes, which manifest themselves, not merely in the levels of concepts and hypotheses, but also in the levels of inferior and superior awareness. The psychological possibility of the operations of introspection and retrospection, which represent special cases of higher level awareness, lead to the problem of the continuity of thought processes.

The two forms of cognitive continuity, revealed by critical introspection and confirmed by empirical evidence, may be distinguished: (1) The continuity manifested by the associative connections *between* the contents of consciousness (e.g. The formation of proactive and retroactive associations as a function of the similarity, frequency, intensity, and proximity of the cognitive elements). (2) The continuity manifested by the association *of* the contents of consciousness *with* the consciousness itself, the former being represented by the series of concrete images as well as the set of general concepts, and the latter by the psychological unity of apperception and reflection.

The contemplation of the *train of thoughts*, that is, the engagement in the *over-operation* of the inspection of the cognitive *operations*, is psychologically possible, and its logical consequence is the self-awareness of the *thinker* as the *operator*. The phenomenon of retrospection which presupposes the continuity of thought, furnishes an excellent illustration. When one reviews a series of images in retrospection, which images are the reviewed and which the reviewer? When one compares in thought one image with another image, which is the comparer and which the compared? When one entertains a train of thoughts, which thoughts are *on* the train and which the spectators *by* the train? Neither.

For all of these are lower level awarenesses which are brought together in the continuous medium of a higher level awareness. Retrospection is thus made possible by the continuity of the higher levels of thought. And it may be observed that, while the retrospection of a train of thoughts takes place in time, the contemplation of time itself as duration presupposes the continuity of thought. Considered in this light, the very contemplation of psychological elements constitutes the clearest repudiation of the doctrine of psychological atomism. Consider, for example, the classic case of Hume, introspecting into the psychological contents of his own mind, and declaring: "The mind is a kind of theatre, where several perceptions successfully make their appearance; pass, repass, glide away, and mingle in an infinite variety of postures and situations" (cf. *Treatise of Human Nature*, I:iv:vi). Hume consequently defined the self as a "bundle of perceptions". The modern positivist and behaviorist conception of mind is not essentially different from that of classical empiricism; and the same critique applies to all of them collectively. From the psychological standpoint, the case of Hume appears to suffer from two handicaps: In the first place, it suffers from the fallacy of "incomplete introspection". For, if the mind consisted of *nothing but* a theatre of perceptions, then how could it possibly be at the same time the *spectator* of this theatre? If the mind were nothing but an aggregate of perceptions, then it could not possibly *describe* the fact that it is nothing but an aggregate of perceptions. In the second place, to take the *objects* of thought for the *subject* of thought is to fall into what James has called the "psychologist's fallacy". This fallacy consists of a confusion between the subjective stream of experience and the objective stream of psychological phenomena, that is, a confusion between self-introspection and other-introspection. In self-introspection, concentrating on the *objects* of thought, the fallacy is to overlook the *subject* of introspection. And it is in other-introspection that we see clearly that, not merely the objects of the *other* thought, but also the subject of the *other* thought, both constitute the objects of the psychologist's study.

With respect to the continuity of thought processes, two things may be noted: First, that it is a bidimensional attribute, being both longitudinal and transverse; that is, it extends through the temporal dimension as well as through the horizontal structural dimension. Second, that it refers, not to the contents of thought, but to the higher levels of thought processes; that is, it is the "stream" and the "fringes" of thought that are continuous and not the objects of thought. In a recent study of the genetic aspects of cognitive processes, Wolfgang Metzger (226) of the Universität Münster has constructed the following classificatory schema: (1) Cognitive functions (*Erkenntnisfunktionen*) consisting of those basic faculties which are the "conditions of the possibility of all experience". These Kantian categories include consciousness, memory, etc. (2) Cognitive processes (*Erkenntnisprozesse*) consisting of the processes of perceiving, thinking, learning, attending, etc. (3) Cognitive contents (*Erkenntnisinhalt*) consisting of the phenomena of the stream of experience in general. The cognitive functions are the preconditions of cognitive processes, and cognitive processes are the preconditions of cognitive contents. Relating our hypothesis of the continuity of thought to this classificatory schema, it may be observed that continuity is a trait of cognitive functions and of the higher levels of cognitive processes but not of cognitive contents. Evidently, the *association* between the elements of cognitive contents requires the continuity of thought. For, otherwise, the "train of thought" would remain a disconnected train. And even if the *association of* mental elements were possible in the absence of the continuity of thought, the *consciousness of* the same association would still remain an impossibility.

If our hypothesis, concerning the continuity of thought, be valid, then the phenomenon of continuity must manifest itself, not merely in the structural dimension of thought processes, but also in their longitudinal dimension. That is, the continuity of thought must be either a correlate of the phenomena of memory or a condition thereof. For, analogically expressed, the fabric of memory is knit with the fibers of past associations. That recollection implies the inherent continuity of memory, may be illustrated by what we shall call the phenomenon of *reverse recollection*. In this case, one recalls, not the last event in the series of experienced events, but some event prior to the last event. For example, one may attempt to recall the last event before one left a certain place; and, for some definite reason, one finds that one cannot recall that most recent of events; instead, one recalls another event previous to the last event, and the memory of the former then brings back the memory of the latter. Thus reverse recollection operates in a roundabout fashion: To retrieve the most recent event of the past, it must first go back to an event in the remoter past, and from there retrace its continuous path forward again. It is our contention that neither the phenomenon of direct recollection nor of reverse recollection could take place without an underlying continuity of thought processes.

The history of the concept of continuity in psychology may be traced to the work of William James (146). In an age when the elementism of classical empiricism (Locke and Wundt) appeared to be the dominant trend in psychology, James pointed out the logical incompatibility of that doctrine with the phenomena of psychology. Since we have already written a critique of the doctrine of atomism, which positivism and behaviorism maintain to this day, we shall say nothing more about it here (cf. Chapter 3: Phenomena of Perception). James described the thought processes (consciousness) in terms of a continuous "stream" involving two interwoven trends: The substantive states, which are relatively stable, and the transitive states, which are relatively fleeting. Furthermore, there are the "fringes" of consciousness which constitute the psychic overtones of its mainstream. For James recognized the integrative and configurational aspects of thought processes as well as of perception; and it is for this reason that Thorndike (337), in his assessment of the contribution of James to the psychology of thought, credits him for being the "forerunner" of gestalt psychology. Extending the concept of continuity to the conception of the self, James distinguished between the "empirical self" and the "transcendental self", the former being a discrete aggregation and the latter a continuous unity. Thus when Peter and Paul awake after sleep, Peter is still Peter and Paul is still Paul; their personalities are never interchanged. Sleep may interrupt the continuity of the empirical self, when practically everything about oneself is forgotten, but the underlying continuity of the transcendental self will continue, through waking hours and sleep alike, as the subjective correlate of the continuous stream of experience. If later James (147) appears to have described consciousness in ostensibly physiological terms, it was not that he had reverted to a crude reductionism, but that he had adopted an epistemology of homogeneous phenomenalism which transcended the duality of the mind and the body. For the Jamesian "pure stuff of experience", as it later emerged in the context of his philosophy, was neither a material nor a mental substance. But we shall refrain from entering into a discussion of the epistemology and metaphysics of James here. Suffice it to remark that, not merely the philosophical theories of James, but also his psychological theories have been either neglected or misrepresented in the contemporary intellectual scene. Therefore this writer is pleased to refer the reader to the excellent systematic study of the psychology of James by Dr. J. Linschoten (202) of the University of Utrecht, who has recently developed, in the light of phenomenology, the theoretical ramifications of the psychological theories of James and their implications for contemporary psychology and philosophy.

The psychological conception of the continuity of thought (e.g. James) is essentially a different conception from the classical philososophical conception of it (e.g. Plato). The two conceptions are to be distinguished with respect to the nature of the evidence on which they are based: In the former case, this evidence consists of the observation (introspection) of psychological phenomena; in the latter case, of dialectical logic. It may be noted, however that many a modern philosopher who maintained the hypothesis of continuity, in one form or another, found it necessary to adopt a psychological approach. In this category belong: Kant (157), who adopted the concept of the "transcendental unity of apperception" as a necessary condition for the lower level psychological processes; Frege (97) who described consciousness as the necessary "bearer of images"; Whitehead (365), who based the conception of consciousness on the psychological process of "recollection"; and evenWittgenstein (369), despite his followers, recognized the continuity of thought in one of his far-fledged insights: "To draw a limit to thinking we must be able to think both sides of this limit". If the genetic theory neglects to incorporate the concept of continuity into its theoretical framework, it is certainly not because of an unawareness of the existence of the phenomena of consciousness. Indeed, Piaget (265–III) himself has observed that: "*La conscience existe à titre de phénomène*". It must be noted, however, that it is the *states of consciousness* that exist as phenomena; and that *consciousness itself*, as the substantive medium of the transitive states, may be regarded as an inferred entity. The genetic theory and the gestalt theory both have inherited the principle ofpsychophysical parallelism from the psychophysics (Fechner). But, while the sensationist elementism of psychophysics was transformed in the context of genetic psychology into the operational elementism, gestalt psychology has been able to avoid elementism altogether by means of the hypothesis of psychophysiological isomorphism (represented by the later researches of Köhler) which we have discussed previously.*

* *Note on the "Field of Consciousness":*
The *continuity* of thought processes constitutes the necessary condition for the unity of the *field* of consciousness. Hence, the concept of "continuity," as we have described it, implies the integration of cognitive configurations within the general "field of consciousness." However, in view of the intensive analysis of the phenomena of the "field of consciousness" (*champ de la conscience*) by Aron Gurwitsch (117), and the resulting phenomenological "field theory," we shall refrain from a duplicate investi-

Conclusion

The foregoing sketch of the morphological analysis of thought processes has sought to describe, from one angle, the *psychological dichotomies* (involving types and levels), and from another angle, the *psychological affinities* (involving the genetic order and continuity) of the "higher mental processes". (The schematic representation of above is to be understood merely as a symbolic indication of these aspects of the thought processes).

The significance of our morphological theory, and its implications for the contemporary controversy in psychology and philosophy over the nature of the phenomena of thought, must be made clear. The perennial problem of cognitive psychology, from the classical "Denkpsychologie" to the contemporary "Field Theory", has been to determine the *nature of* the thought processes. The usual formulation of this problem has been as follows: "What is it that we think *with*?", or more precisely, "What is the constitutive substance of the configurations and operations of thought?". Psychologists have asked this question of themselves, as well as of their experimental subjects, both by direct and indirect methods. And if it appears that this problem has never found an adequate answer, it is because all the answers have tacitly assumed that there must be only *one kind* of thinking, and therefore, one material with which we think or which thoughts are made of. Accordingly, the psychology of thought has been crowded with a set of conflicting solutions to the problem. These solutions have ranged from the hypotheses of sensationism and imagism to those of symbolism and transparentism. Parallel to these psychological viewpoints, a set of conflicting views have occupied the philosophical scene. And this controversy shall continue as long as the typology of the thought processes, upon which the solution of the problem depends, remains neglected. However, if our morphological analysis be valid, than the solution of the same problem may be indicated along the following line: *What* we think *with*, and how we think, is a *psychological function* of the *type* of thinking

gation here. Suffice it to note, besides our sundry references to the work of Gurwitsch in other contexts, that: The analysis of the "formal invariant" of consciousness, on the basis of the schema of "theme—thematic field—margin," and the resultant dichotomy of „gestalt-coherence" (relational integration of the elements of the *theme* and "gestalt-relevenace" (relational integration of the themes within the *thematic field*), as the twofold noetic core of the field of consciousness, of which "marginal consciousness" and its data constitute a contingent periphery, represents the theoretical correlate of our morphological study of thought processes and specially sheds light upon the problem of the *continuity* of thought.

we are engaged in. It follows that the various psychological viewpoints (excepting the superficial linguistic interpretation), relative to the nature of the thought processes, are all partially correct and generally complementary. For these viewpoints are concerned with the various aspects of the different types of thought processes which the morphological theory has outlined. Thus, for example, the imagist viewpoint describes the imagist type, the symbolic viewpoint the conceptual type, the problem-solving viewpoint the hypothetical type, etc. If the present morphological study contributes to the settlement of the current one-sided quarrel between the different psychological viewpoints, by means of an objective synthesis, then our labor will not have been in vain. Gestalt psychology had the right insight, long ago, when it introduced the concept of "structure" into the interpretation of the thought processes. Without the concept of "structure", besides other things, the morphological analysis of the higher mental processes would have not been possible. In any case, at least this much has been established: That the thought processes have a psychological reality, which lies beyond their behavioral manifestation, and they deserve, no less than the forms of the plants, our careful study.

Our remaining observations will be brief. In the highest biological organism, the patterns of thought apparently transcend their elements, the operations of thought seem to overflow their contents, and the "higher mental processes" remain half-way beyond the scope of physical reductionism. Naturally, it is easier for the introspective psychologist, to contemplate the transparent *Bewusstseinslage*, than to precipitate the opaque belief that thinking consists of *nothing but* the objects of thought. But, since the morphological analysis of thought processes has brought us the knowledge of essential forms, we no longer need to confine ourselves to the introspection of the transparency of consciousness. Moreover, contemporary biology and psychology, after a period of prolonged divergence, are manifesting a theoretical convergence in the study of the "cognitive phenomena". And, in view of the fact that a profound gap, however gradual, extends between the lower and the higher vertices of the phylogenetic scale of evolution, it would be naive to stipulate the forms of the higher mental processes in man after the behavior model of the white rat or the dog. For, the essential principle of comparative psychology, to the effect that, given the validity of the biological evolution of species, the study of the lower forms of life will shed some light upon the nature of the higher forms of life, is not logically reversible. Indeed, on the basis of the same principle, the higher forms possess special traits, besides the continuity of the common zoological traits, which are not possessed by the lower forms. Accordingly, Rensch (300: p. 334) has formulated the critical problem of comparative biology (which is equally applicable to comparative psychology) as follows: "...It will be necessary to analyze the manner in which the number of psychic phenomena decreases as we go from higher to lower levels of the phylogenetic tree, and to establish which phenomena should probably be regarded as the oldest in phylogeny". The objective of comparative psychology, namely, the investigation of the convergencies and divergencies of the psychological traits of the various biological species, is intrinsically incompatible with any form of crude reductionism. Yet, modern behaviorism has rejected the study of the "higher mental processes"; while psychoanalysis has buried all but the pragmatic periphery of consciousness in the underground of the unconscious. The time has arrived for psychology, if she has outgrown the metaphysical phobia of her nascent years, to resume the study of the phenomena of consciousness in the experimental laboratory. It is significant that the field of consciousness has been recently rediscovered, in the context of empirical psychology (especially through the research of Gurwitsch (117)) as well as of experimental biology (especially through the research of Rensch (300)), as a *psychological phenomenon* beyond the phenomena of behavior. Sometimes it appears as if it has been altogether forgotten that *psychology* is the sole science of mental phenomena amongst the family of the natural sciences. This is to be attributed, in this case, to the psychological transformation of the classical "soul" to the modern "ego" which has involved, among other things, the substitution of the operational term of "awareness" for the introspective concept of "apperception". Let us, then, preserve the concept of "awareness" and its psychological meaning consistently: If "awareness" means *nothing but* the behavior reorientation of the organism in a given context, then the usage of this term will add nothing to the existing concept of behavioral "response"; if, however, the term is to have a special meaning, which will justify its current usage and preservation, then "awareness" must be taken for what it is, namely, the cognitive function of the field of consciousness.

The implications of our morphological analysis for clinical psychology, and specially for the pathology of the thought processes, may be briefly hinted. We have seen, in a previous context, that the varieties of pathological thinking represent the deformation of the various types of thought processes in various combinatorial proportions (cf. Chapter

5). It is very possible that one type of thinking may be deformed to a greater extent than another, but, since the various types are functionally interwoven, the dysfunction of one type will have pervasive effects upon the functioning and organization of the other types. In this respect the following hypothesis may be formulated: Theoretically, the effects of the functioning of the genetically prior type of thinking upon the genetically posterior type of thinking is far greater than the effects of the latter upon the former. Thus, in cases where the imagist type of thinking has been impaired, the impairment of the conceptual and hypothetical thought will eventually, and necessarily, follow. In contrast, in cases where the conceptual and hypothetical thought are impaired, from this alone, the impairment of the imagination (productive or reproductive) will not result. Indeed the psychological study of "pathological art" confirms this hypothesis: Psychopathological patients, whose abstract thought processes are grossly impaired, an impairment which manifests itself in their paralogical thinking, nevertheless display a relatively stable capacity for reproductive and productive imagination (cf. The data collected by Anastasi & Foley(15)). It may be noted further, as a case of comparative parallelism, that abstract concepts are generally absent in the thinking operations of primitive peoples, while these same peoples demonstrate a remarkably good perception, and correspondingly, a vivid imagination. This fact, in turn, explains the rare incidence of "concept-words" (e.g. "walking") and the abundant redundancy of "percept-words" (e.g "walking-with-stubby-feet", "walking-with-long-legs", "walking-with-shaking-limbs", etc...) in the primitive languages (cf. The study of primitive thought by Wertheimer (82)). It is a corollary of our hypothesis, that the memory of general concepts may continue to remain long after the perceptual images of the objects, which originally constituted the range of the concept, have perished. Thus the case of the patient suffering from "figural blindness", reported by Gelb & Goldstein (101), indicates that the subject continued to retain his conception of the object after he had forgotten the perception of it: "He drew a boot, not *the* boot presented". (In contrast, the "blind sculptor", who suffers from uniform "color blindness" rather than from "figural blindness", represents a case of perperceptual limitation rather than perceptual degeneration). However, in cases of eidetic aphasia, where the empirical basis for the rational generalization remains absent, the attainment of new primary concepts becomes an impossibility.

At the termination of our theoretical study of the morphology of thought processes, it is to be expected that the experimental psychologist should ask the characteristic question: Where is the statistical evidence that provides the basis for these hypotheses? (Indeed this is precisely the same question that has been asked concerning the cognitive theories of Wm. James contained in the great *Principles of Psychology*). And our answer will be the following: To begin with, the methodology of qualitative analysis, which we have consistently applied, is logically sufficient for morphological studies in general, and therefore, "statistical methods" are dispensable in studies of this nature. In the second place, unlike the great James, we no longer stand alone: For gestalt psychology and genetic psychology have provided us with corroborative theoretical schemata which are firmly grounded in experimental phenomena to which analytic references have been made. Finally, in defence of Theoretical Psychology (as the branch of natural science of which this author claims a special knowledge), it may be pointed out that there exists, in the realm of the higher mental processes, a class of highly intricate and subtle phenomena, which can be only roughly pinned to the experimental dissecting table, and the refined ramifications of which have consistently surpassed the ingenuity of the experimentalist. And the methodological way out of this predicament consists of two alternatives: The one being the neglect of, and even the denial of the reality of, this special category of phenomena; and the other being essentially a return to the method of qualitative experimentation reinforced by the method of theoretical morphology. Those psychologists who have adopted the first alternative have done so at the price of their scientific objectivity. Despite the progress of experimental psychology in the assessment of phenomena, theoretical psychology must necessarily keep a half-step ahead of it, for without the theoretical integration of discrete data there can be no scientific knowledge. As for the method of experimental introspection (direct or indirect) it remains, if not the "first and foremost" method of psychology, as James and Wundt maintained, at least the method of *last resort*. And if the resultant theoretical construction illuminates the way for the tentative hypotheses of the experimentalist, then not everything will have been in vain. Lately a methodological distinction has been made between the "controlled experimentation" and the "controlled investigation", the former referring to the experimental research, in the strict sense, and the latter to empirical and theoretical research. It has been a commonplace objection to the method of controlled investigation that it is not always susceptible of "public verification", in the full degree, as is the case with the method of controlled experimentation; and that, consequently, the practice of the former places the brunt of possible criticism upon the insight of the scientist rather than upon his apparatus. It is sufficient to point out that, since scientific research intrinsically involves both observation and interpretation, the trained insight of the scientist is at least as important as his precision apparatus, if indeed not infinitely more. In any case, logically speaking, matters of truth in natural science cannot be decided by the democratic principle; and the complete democratization of science would result in the purge of science of its most advanced theories. It is evident that natural science (including the nascent science of psychology) cannot afford to dispense with either of the two general methods of controlled research. It may be noted, lastly, that the "morphological theory" which we have sketched constitutes a theoretical supplement to the gestalt and the genetic theories, the latter being complementary to each other, and by no means presents a theoretical alternative to these. Indeed there is to be found in European cognitive psychology a variated range of corroborative evidence of which we have sampled but sparsely (cf. Related volumes of the encyclopaedic *Handbuch der Psychologie* (120) especially I: 1 & 2 and III).

PART TWO

PHILOSOPHIC FOUNDATIONS OF EMPIRICAL PSYCHOLOGY

CHAPTER 7

ANALYSIS OF BASIC CONCEPTS

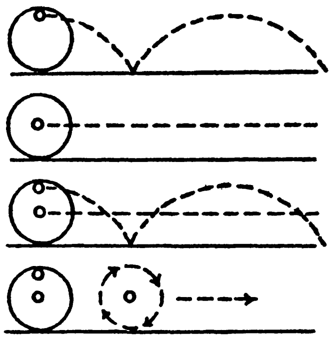
The concepts of *abstraction* and *configuration,* in the last analysis, are the fundamental concepts in the psychology of perception and thinking. We have examined the concept of "gestalten" and their "structuring" in the context of gestalt psychology, the concept of "operations" and their "interiorization" in the context of genetic psychology, and the concept of "psychological patterns" and their "formation" in the context of functional psychology. From the theoretical standpoint, as we have noted before, these varied conceptions involve a common process, abstraction, and result in a common product, configuration. We shall then, in this chapter, undertake a logical analysis of these basic conceptions.

The *logical analysis* to be presented in the following pages is essentially different from thefashionable "linguistic analysis" in the following respect: The former consists of an analysis of the logical structure of conceptions and the interrelationships thereof; and the latter consists of a taxonomical survey of the related linguistic usage. We shall not care in what ways the nomenclature related to our basic conceptions is used in ordinary language; we shall disavow all interest in the sociology of language whatever its alleged worth may be. Our concern here is deeper: Stated generally, we wish to investigate a portion of the logical structure of reality. Specifically speaking, we would like to inquire: What is the nature of the process of abstraction? In what sense may the process of abstraction be regarded as being transcendent to the process of perception? What is the logical difference between abstract ideas and concrete images? And if abstract ideas be psychological configurations, then what is the nature of these configurations? The problem of abstraction is an ancient problem; that of configuration is a recent problem. And in this case, as it frequently happens in the history of science, the new provides the clue toward the solution of the old.

I. CONFIGURATION

Our psychological investigation reveals that configurations remain, whether in the form of "gestalten" (gestalt psychology) or "operations" (genetic psychology), phenomenological entities with special epistemological properties. We have previously described two kinds of configurations: (1) *Perceptual configurations*, which are essentially "emergent entities" relative to their elements; for they generally display, as wholes, at least one property in addition to the aggregate properties of their elementary components. (2) *Conceptual configurations*, which, being morphologically "transcendent" to their elements, display the trait of transposition; that is, their abstract forms always outlast, in the new context, the elimination of their parts, in the old context. The classic representation of these types of configurations is given by the *Ø-gestalten* and the *Θ-gestalten* in the context of gestalt psychology, which we have studied in detail previously (cf. Chapter 3: I & Chapter 5: I).

The thesis to be maintained here is that psychological configurations, in principle, are irreducible to their physical components; and that, consequently, the psychological language cannot be translated into the physicalist language without remainder. The empirical evidence for this viewpoint has been provided by gestalt psychology and genetic psychology. The experimental studies of perception and thinking have demonstrated repeatedly that configurations, because of their inherent traits of transcendence, cannot be completely defined in terms of the aggregates of their components. The class of phi-phenomena and the transposition phenomena constitute the best illustration of these configurations. And these phenomena are to be explained in terms of the principles of functional and topological synthesis in the context of the field theory (cf. Köhler (171) (173)). The conception of the "irreversibility" of perceptual structures, in the context of genetic psychology, indicates nothing else than the irreducibility of psychological configurations (cf. Piaget (266) (273)). Of the numerous experimental studies suffice it to recall two typical cases of the Ø-gestalten: (1) The phenomena of apparent movement: A rolling wheel in a dark chamber describes, with a light-spot in its center, a horizontal line parallel to the plane, and again with a light-spot on its rim, a regular cycloid; but given both lights simultaneously, then the result is not the expected overlapping of the straight line and the cycloid curve, but rather the appearance of a rotating circle. This is illustrated by the diagram, where $(a+b) = d$ instead of c. This phenomenon, as a species of the



(Adapted from Wallach: "Perception of Motion," Scientific American, 201 (1959)).

phi-phenomena, is to be explained by the Kortean law, $\emptyset = f\ (s/it)$, describing the functional relationship between the appearance of movement and the ratio of spatial factors to the factors of light intensity and time (cf. Wallach (349)). (2) The phenomenon of concentric figures: Given two squares (S_1 and S_2) such that S_1 is enclosed within the larger S_2 and the spatial difference between the two figures is described by the area (A); then, *physically* the configuration may be described by the equation $(S_2-A) = S_1$, but *psychologically* this description will not be correct, since the physical proportions of the separate figures are not preserved in the context of the configuration; that is, $(S_2-A) \gtrless S_1$

(S_1 after the integration with S_2 appears larger than before).

depending upon the structural ratios of the configuration (cf. Oppenheimer (243)). The illusion of the "concentric circles", analyzed by Piaget (279), which we have described in the chapter on perception, can be theoretically derived from the general principle of the phenomenon of concentric figures. The theoretical significance of these phenomena, formulated in detail by Köhler (173), is summarily restated by Piaget (266: p. 68): "If we are to translate the relations occurring in these perceptual changes into operational language, it is obvious straight away that their combination could not be additive, because the conservation of the elements of the system is lacking... This is the essential discovery of the gestalt theory and, according to the theory, characterizes the idea of perceptual 'wholeness'." And what holds true of perceptual configurations applies, *mutatis mutandis*, to conceptual configurations. It may be concluded that the empirical evidence for the transcendence of configurations consists of the qualitative transformation of the physical elements, through the process of synthetic integration, resulting in the configuration (cf. Chapters 3 & 5).

The logical analysis of the concept of *gestalt*, in the context of psychology, is corroborated by contemporary research in physiology. It will be sufficient to describe here the work of F. J. J. Buytendijk (53) (54) in the University of Utrecht (Cf. also the interpretation of advances in neurophysiology by Köhler (177)). Buytendijk has analyzed the results of the experimental studies of the functioning of the nervous system, specifically the threshold responses in the context of the pheıal system, in the effort to determine the relationship between the "part" and the "whole". Perhaps the most significant of these results is that the phenomenon of the threshold in the isolated nerve is functionally dependent upon the nature of the stimulation, involving both quantitative and qualitative variation, as well as the conduction of the nerve. In the case of a completely unstructured stimulus (e.g. electrical stimulation), of which the quantitative variation can be accurately measured, the threshold of the stimulus is determined, not merely by the *volume* of the increase, but by the *rate* of the increase of the current. And since the rate and the ratio of variation are qualitative changes, consequently, the peripheral nerve responds to the configuration of the stimulus and not simply to its intensity. Indeed it has been demonstrated that it is possible to allow an electric current to creep in under the threshold, very gradually, without stimulating even when it reaches maximum intensity, but only resulting in polarization. It follows that the gestalt of the stimulus, which alone passes over the threshold, is to be described as a "whole" which is something more than the sum of its quantitative "units". And if what we have said is true of the peripheral system, it is true, *a fortiori*, of the central system which is more integrative in its functioning. From this class of experimental phenomena Buytendijk deduces two principles applicable to physiological psychology: (a) "The organism is only stimulated when the gestalt *appears* to it"; and (b) "When a stimulus which has passed the threshold is effective through its gestalt, then there are no longer stimuli which can be distinguished quantitatively". In the light of these principles are to be understood suchfundamental conceptions, as the "all-or-none law" (Müller) and the "psychophysicol law" (Fechner), which have resisted mechanical explanations. Further, in the same light, a distinction is to be made between the physiological concepts of "irritability" and "excitability", with respect to their static and dynamic implications respectively, and the corresponding psychological concepts of "proximal stimulus" and "distal stimulus". The consequences of these principles for a systematic theory of the nervous system are highly significant; but it is beyond our scope here to discuss the subtle "loom theory", in the context of which form (gestalt) and function (process) blend together, through the successive transformations and equilibria of the states of the engram, manifesting the diverse phases of an underlying equipotentiality, and refer the reader to the treatise of Buytendijk (53) concerning the subject.

Besides the empirical evidence cited, there is a logical argument for the irreducibility of psychological configurations to their physical components. This is, naturally, a more conclusive argument by its logical nature. It may be stated as follows: Given a configurational system (S), with its component elements and relations, at the *level-Ø* (phenomenal level), then (S) will display a set of phenomenal properties (a. b. c.... and f). And given a theoretical schema (T), at the *level-π* (physical level: physical semantics), in the context of which S is to be interpreted, then T will be able to account for all the physical components of S and their respective properties (a. b. c...) at least in principle. But at least one property, f, of the configuration S, at the *level-Ø*, will remain transcendent, in principle, relative to the theory T, at the *level-π*. Therefore, all psychological configurations, being at the phenomenal level, are in principle irreducible to their physical components, without remainder, by any physical theory. Perceptual and conceptual configurations both are transcendent entities; the former with respect to their wholistic quality, and the latter with respect to their logical generality. (The reader may note that our analysis of the logical conditions for the transcendence of psychological configurations is corroborated by the recent study of Rescher & Oppenheim (301)). This argument leaves two alternatives open to the physicalist: He must either deny our empirical premise to the effect that Ø-phenomena exist in nature, or he must admit the limitation of the scope of explanation of the physicalist theory. In the former case, he will have objective facts stacked against him; in the latter case, he will have abdicated the universality of the physicalist language.

According to logical positivism, however, psychological configurations are reducible to their physical components. The recent presentation of its case is as follows (cf. Bergmann (34) & Madden (210)).

From the paradigm of *n*-bodies in classical physics we learn that a physical system consists of a set of elements with specific masses, accelerations, and spatial positions. A complete description of such a system consists of the specification of the properties of its elements *plus* the relations between them. Consequently, if the gestaltist hypothesis—that "the whole is more than the sum of its parts"—means that the description of a configuration must include not only its parts but also the relations between them, it is valid, but then it is translatable into the physicalist language. If, however, the gestaltist hypothesis means that the configuration is something more than the sum of its parts *and* relations, then it is a meaningless assertion. Thus they hope to have at last caught psychology between the traps of "reductionism" and "meaninglessness"; and we shall see whether the philosophy of science is resourceful enough to rescue it from this doubletrap of physicalism.

The logical critique of the physicalist argument may be stated as follows: What renders this argument invalid is not simply the fact that it is, in effect, a refined resurrection of the crude "bundle-hypothesis" the invalidity of which has been demonstrated by gestalt psychology. It is rather that this argument, by equating the psychological configuration with the corresponding physical system, is guilty of the reductive fallacy". The *reductive fallacy* may be described as the identification of two objects when these objects are located at different phenomenological levels. Thus, for example, while it would be correct to say that colors are correlated to wavelenghths, it would be fallacious to say that colors *are* wavelengths. The diagnosis of the reductive fallacy is a corrolary of the logical argument, for the transcendence of configurations, given previously. It follows then, that since the psychological configuration is not identical with the corresponding physical system, the former is not equivalent to the sum of the components of the latter. Thus if Ø represents the psychological and the *P* the physical; then the logical form of our critique may be state in this way: Since (Ø-configuration $\neq$ P-system), and since (P-system = Aggregate of P-components (elements & relations)), therefore, (Ø-configuration $\neq$ Aggregate of P-components). The configuration is the synthetic product of is own psychological components. And what has been demonstrated about Ø-gestalten applies, *a fortiori*, to Θ-gestalten. Consequently, the proposition of gestalt psychology, to the effect that "The whole is more than the sum of its components", really means that "The psychological whole is more than the sum of its *physical* parts and relations". It may be concluded that configurations, being transcendent entities, cannot be adequately described in the physicalist language. The scientific study of these configurations remains the exclusive *Aufgabe* of psychology which, as a member of the family of the biological sciences, has developed its own descriptive and explanatory methodology.

We have seen that configurations are a special class of structures. And we have argued that configurations have a reality of their own, together with the laws that regulate their formation and transformation. If this be true, then the *concept of structure* should bear some basic implications for the problems of psychology, as it does for the problems of other natural sciences. This in fact does happen to be the case. Classical psychology maintained the genetic principle that form follows function: *La fonction fait l'organe* (cf. Boring (40)). This principle was the progenitor of Lamarck's hypothesis of acquired traits; and Darwin's concept of adaption, in the context of the theory of biological evolution, was the logical consequence of it. And, for a time, even in American functional psychology the term "functional" was associated with the same principle. But modern psychology has become at last conscious of the importance of the concept of structure. Accordingly, it has come to recognize, besides the principle of functional determinism, the principle of structural determinism: To the effect that, not only the function may determine the form, but also the form determines the function. The range of phenomena, from those of gestalt psychology and genetic psychology to functional psychology (especially differential psychology), provide abundant illustrations for this synthetic principle. (It would be reasonable to expect that, if ever the psychological explanation is to be discovered for the strange phenomena of parapsychology—namely the phenomena of extrasensory perception (ESP) and of psychokinetic effect (PK) reported by J. B. Rhine—it will perhaps be in terms of the concept of intersubjective isomorphism). In any case, configurations, as the phenomenal objects of perception and thinking, constitute the subject-matter proper of psychology. The study of the external behavior of organisms acquires importance only when this behavior is interpreted as a manifestation of these implicit psychological configurations. Considered in this light, psychology possesses a phenomenological autonomy: While it shares relevant information with other natural sciences, it remains in principle irreducible to any of these. The ramifications of the relationship of psychology to other natural sciences (especially physiology and physics) will be examined later (cf. Chapter 9).

The same may be said of psychology's sister natural sciences. In biology the study of morphology has always constituted the core subject; for both systematic botany and comparative anatomy are based upon the principles of morphology. Likewise, in physiology a "structural school" has been of late developed to remedy the shortcomings of the "elementistic school" (cf. Goldstein (109) and Köhler (177) and Buytendijk (53)). The central branch of chemistry, stereochemistry, studies the structural aspects of chemical compounds (in contrast to their contents). And stereochemistry has demonstrated that the properties of organic compounds are, among other things, a function of the structural groupings of their elements. The phenomena of isomerism and polymerization constitute the finest illustration of how a purely structural change, without any quantitative addition or subtraction of the elements, results in a change in the observed properties of chemical compounds. As for physics, not merely does it have its own "physical gestalten", to use the terminology of Prof. Köhler, but also it has come to lose the "material substance" that once formed its subject-matter. For we no longer seem to know what "matter" is; and "What is matter?" is the question that haunts the modern physicist (cf. Van Heerden (345)). Consequently, the description of the nature of physical reality, by Margenau (219) and by Eddington (80), is in terms of structure rather than of matter. Eddington (80: p. 142) writes: "Physical science consists of purely structural knowledge, so that we know only the structure of the universe which it describes. This is not a conjecture as to the nature of physical knowledge; it is precisely what physical knowledge as formulated in present-day theory states itself to be".

Our concluding remarks will be brief: In the first place, the concept of structure has altered the direction of epistemology, from the study of the element to the relation, from the content to the form (cf. Chapter 9). In the second place, the concept of structure has changed the perspective of the philosophy of science. For the concept of structure constitutes the basic affinity between the various natural sciences; and this structural affinity is more fundamental than any microscopic relationship along the borderlines between the sciences. Consequently, from the standpoint of phenomenological realism, the study of the structure of science, rather than that of the "language of science", constitutes the fundamental task of the philosophy of science (cf. Chapter 10).

II. ABSTRACTION

The distinctive characteristic of thought, in contrast to perception, is that its operations are independent of space and time, even though the thinker occupies a spatial locus and his thinking runs a temporal course. We have previously compared the processes of perception and thought, with respect to the proximate nature of the former and the remote nature of the latter, and have described their essential differences as well as interrelationships (cf. Chapters 3 & 5). The outstanding problem emerging from our previous investigation is the following: What is then the explanation for these fundamental differences between perception and thought, rendering the former a limited operation capable of only proximate cognition, and the latter a powerful operation with a general range of distant cognition? It is now evident that the answer is to be sought in the analysis of two essential processes and the meanings of the two words that stand for these: *inference* and *abstraction.* For in every case, it is hypothetical reasoning that proceeds from the observable data to the unobservable entities; and it is conceptual reasoning that advances from the particular objects to their general classes. In a psychological chapter we have demonstrated that these operations correspond to essentially different types of thought processes (cf. Chapter 6:II). Further, we have maintained, with respect to the logical nature of psychological configurations (especially the Θ-gestalten), that they are to be regarded as transcendent archetypes relative to the range of concrete objects corresponding to them, and that this transcendence is attained by the process of abstraction. In the following, then, we shall undertake an analysis of the process of abstraction from the epistemological point of view.

The process of *abstraction*, considered primarily as a psychological phenomenon, consists of the formation of a general conception on the basis of the observation of a number of concrete perceptions. However, psychological phenomena, in the realm of cognition, entail epistemological schemata. As an epistemological function, abstraction may be analyzed into its elementary operations of: (a) *Subtraction* which consists of the elimination of the specific properties of the object and the retention of its general properties; and (b) *intensification* which consists of the logical integration of the remaining properties following the termination of the operation of subtraction. The problem of abstraction, then, dissolves into a pair of corresponding problems concerning: Firstly, the logical difference between the specific and the general properties of objects (presupposed in subtraction); and secondly, the epistemological nature of the structural integration involved in the intensification of the abstract idea. We may base our logical distinction between the *essential traits* (consisting of properties necessary for classification) and the *peripheral traits* (consisting of properties not necessary for classification) upon the schemata of theoretical biology (especially *Biotypologie* where such a classification of traits is presupposed as an absolute schema but with a relative range of application (The general problem of types is discussed elsewhere in this treatise (Chapter 10:1)). With respect to the integration of the essential traits, resulting in the intensification of the abstract idea, it is to be interpreted in the light of the process of structuration (*Gestaltbildung*), determining the relationship between the essential traits, itself being determined by the principles of *equilibrium* and *context*, and resulting in the Θ-gestalt as an abstract configuration (These psychological principles have been demonstrated previously (cf. Chapter 5)).*

The abstract entity, as a logical configuration, comprises an intensional entity the definition of which consists of the description of its structure. There are *levels of abstraction*, correlative to the degrees of generalization (*Allgemeinheitsgraden*), and corresponding to the reflective levels of conceptual thought. The logical law of *inverse variation*, which indicates the inverse correlation between the specification of the intension and the range of the concept, is to be derived from the general concept of *Allgemeinheitsgraden*. Also from the same conception has been derived the principle of "logical levels" (especially by Frege and Whitehead) which constitutes an indispensable dimension of modern logic.

* *Illustration:* I shall maintain that I possess the abstract idea of a geometrical figure (e.g. triangle), from which all peripheral traits have been systematically subtracted, consisting of a set of purely essential traits integrated by a logical interrelationship, so that my conceptual triangle is neither equilateral nor scalene, neither large nor small, neither textured nor colored. Can I *have* such an abstract idea of a geometrical configuration bereft of a concrete body? The final verification of the abstract idea, by strict analogy with that of the physical fact, must consist of the possibility of the precise description of the logical structure of the same. The concept of the triangle may be defined in the Euclidean way as follows: "A geometrical figure consisting of a plane bounded by three straight lines forming exactly three angles with a summative magnitude of 180 degrees." (Indeed the very idea of a concrete geometrical figure is absurd, in the light of the abstract nature of the constitutive elements of Euclid (e.g. the *point* and the *line*) and of his further theoretical constructions.) And since I am prepared to describe the logical structure of my abstract idea, in this case, by means of a precise definition, tracing the essential traits and the interrelationship thereof, then I can validly claim that, regardless of its ontological status, I have found the epistemological way to the comprehension of its essence.

We have previously examined, in the context of the morphology of thought processes (cf. Chapter 6:II), the conception of abstractive levels and the degrees of generalization.

The logical structure of the concept, as an abstract configuration, transcends the perceptual structure, despite their partial isomorphism. Accordingly, my phenomenological experience of a picture on the wall of a museum passes through two cognitive phases (leaving aside the emotive phase as a possible third): My perception of the picture is itself a pictorial representation comprising of an aesthetic configuration. But my conception of the picture consists of the logical form of this picture, as well as every picture of the same type, as a geometrical configuration. Wittgenstein (369:2.1) says: "We make to ourselves pictures of facts". And I must elucidate: We make for ourselves *two layers* of pictures of facts, the one consisting of our recurrent phenomenal impressions, and the other of the fundamental logical blueprints. Now it is true that every aesthetic picture is also a geometric picture, and further that, every geometric picture is also a logical picture. But the converse is not the case: Not every logical picture is a perceptual picture. We obtain, in the way that has been described, the logical picture through (not to say from) the perceptual picture, but the former remains always transcendent to the latter. It is this logical transcendence of abstract ideas, relative to the perceptions of things, that explain the transposition phenomena in the realm of cognition and recognition. How else could the phenomenological experience of the *same* in the context of the *different* be possibly explained, if not with reference to the two-layer analysis of the morphology of the given? Nominalists appear to be characteristically intensitive to the sublety of the epistemological problem involved: The resemblance of phenomena cannot be explained at the phenomenal level, since its source lies beneath the phenomenal level, and consequently there are cases of the recurrences of the same pattern in the absence of all perceptual resemblance (One might cite numerous examples but one will suffice: The concept of geometrical progression applied to the successive generation of two different species of animals). The ambivalence of nominalism, with respect to abstraction and abstract entities, is illustrated by Wittgenstein (369:2.182), recognizing that "Every picture is *also* a logical picture (On the other hand, for example, not every picture is spatial)", yet in his later writings (which appear to have lost their philosophical depth) insisting: "To repeat: Do not think, but look!". Indeed it would be absurd to confine all research to "looking" without "thinking", especially after we have ourselves admitted that not every "picture" is a perceptual picture. This prescription of "philosophical behaviourism" does not stand in need of any further refutation: For it is doomed, by its inherent contradiction, to logical disintegration, and it will expire of its own accord without leaving a viable progeny. In an old study of the nature of abstract entities, this author arrived at the general conclusion that the logical degree in which a given theory is purged of the incidence of abstract entities is inversely proportional to the epistemological degree in which that theory is able to explain the corresponding range of phenomena in principle (cf. Gobar (107)). Suffice it then to conclude here that, without abstraction and abstract entities, there will be no theory, and without theory no science. We shall examine the nature and function of theories in the context of natural science later (cf. Chapter 8:III).

We have attempted to demonstrate *how* abstraction, as a higher mental process, is logically possible. *That* it is possible, and that as a psychological fact we do form abstract ideas, needs no disputation. For, otherwise, not merely a substantial class of the phenomena of experimental psychology, but also the very epistemological structure of all theoretical science, would remain an unexplained mystery. Yet, the classic critique of the theory of abstraction takes precisely this form, rejecting, not merely the possibility but the data of abstract ideas. Historically English empiricism (especially Berkeley), and more recently logical positivism, represents this genre of criticism. The argument of classical nominalism is stated as follows: It would be impossible to form an abstract idea because, representing the properties of a set of particular objects without itself having any of these properties, it would be a logically inconsistent idea. For example, we cannot have an idea of the triangle, which is neither equilateral nor scalene, neither large nor small, yet all of these at the same time. Clearly, the logical flaw of this argument lies in its confusion of the "logical structure" with the "perceptual structure"; and in its subsequent assumption that the former must display the properties of the latter. It is evidently overlooked that, in order to have a conception of an abstract idea, it is not at all necessary to have an image of it. Indeed, such an assumption tacitly involves the "fallacy of misplaced concreteness", in its epistemological form, as it has been analyzed by Whitehead (365). There is, too, the classic critique of nominalism by James (146) who observed that it is an empirical fact that we do form abstract ideas; and that the doctrine of nominalism is based upon the erroneous assumption that *all* our "ideas" are representative in nature (consistent with the copy theory of perception). However, as we have previously seen, the copy theory of perception is no longer tenable in the light of modern psychology. James (146–I: p. 471) had the correct insight long ago when he referred to "the preposterously false descriptive psychology involved in the statement that the only things we can mentally picture are individuals completely determinate in all respects". Indeed, we may use the Cartesian metaphor, which confirms our logical analysis, to the effect that the *form* of thought is no more affected by the *contents* of thought than the light of the Sun is altered by the diversity of the objects which it illuminates. Let us, then, conclude with Cassirer (60: p. 299): "The ultimate reason for all logical and epistemological disputes over the nature of the Concept is that it was not taken thus, as a pure viewpoint, but as a visible thing, a something that was supposed to have its home in the sensory world, side by side with it or above it". Yet, seventy years after the ringing refutation of Berkeley and Hume by James, after modern psychology and epistemology have transcended classical empiricism, students of philosophy, mainly because of their inveterate ignorance of psychology, still reiterate that "nihil est in intellectu quod non fuerit in sensu", and accordingly persist in maintaining that "ideas" must be subjective "copies" of physical objects. At least part of the trouble, in the perspective of the history of philosophy, is to be attributed to the longstanding practice of the loose usage of the essential terms in English philosophy: What is meant here is that the word *idea* (ἰδέα) has been consistently equated and exchanged with the word *image* (εἴδωλον), especially in the context of empirical nominalism, thus diluting the logical purity of abstract ideas with the texture and color of representation, and indicating an illegitimate departure from the logically authentic tradition of Ancient Philosophy. Phenomenological realism at last, has shed new light over the old problem of the One and the Many, and therefore on the unknown ground of the known object, and has brought within the horizon of our comprehension the possibility of the concrete object as a function of the abstract form, and the explanation of the former in the light of the latter.

CHAPTER 8

METHODOLOGICAL FRAMEWORK OF PSYCHOLOGY

According to a longstanding anecdote concerning psychology, it is a striking fact that the experimental animals of behaviorism behave very much like behaviorists and those of gestalt psychology very much like gestaltists. The moral of this anecdote, it is pointed out, is that psychology shall remain a "subjective science", and that its attempts to achieve the objectivity of biology are doomed to failure. This reasoning obviously reflects a profound ignorance of the function of methodology in the natural sciences in general and in psychology in particular. For it is not in psychology alone, but in biology and physics as well, that the employment of different methods of observation yields different phenomena.

In the natural sciences theoretical controversies are often traceable to discrepancies in the observation of natural phenomena. And these experimental discrepancies are generally rooted in methodological disparities. It appears that at the base of many a theoretical controversy lies a methodological conflict. And if we proceed further in our transcendental analysis, we find that behind every methodology lies an epistemological framework. This epistemological framework is ultimately responsible for the adoption of a particular type of methodology In the last analysis, our theory of *how* we know determines, not merely what we know, but also our *ways* of knowing. It was this truth, no doubt, which Goethe attempted to describe: *Das Höchste wäre zu begreifen dass alles Faktische schon Theorie ist.* It is well for the students of natural science to remember that the startingpoint of science is not "fact" but "theory". The etiology of scientific disagreement lies in the fact that the theoretical method determines the nature of the fact.

It has become fashionable in American psychology to criticize the contributions of European psychology from the standpoint of methodology. Accordingly, the objective of this chapter shall be the investigation of the fundamental methodological problems of psychology, as a natural science, which underlie specific methodological conflicts between the various schools: What are the theoretical criteria by which the methods of psychology may be evaluated? And what constitutes the objective methodological framework appropriate for psychology as a natural science? Beginning with the outline of a methodological critique of genetic psychology (School of Geneva), we shall trace the roots of the critical conflict to the problem of qualitative-quantitative analysis in the context of psychology. And transferring this problem to a larger context, we shall examine the place and function of "theory" in the context of psychological and biological sciences. It is to be hoped that this methodological prolegomenon will contribute to the clarification of the nature of psychology primarily as a qualitative and secondarily as a quantitative science. Accordingly, it will be illustrated that the renaissance of functional psychology in America, because of its methodological objectivity (synthesis of qualitative and quantitative methods), reinforces, and is in turn reinforced by, European psychology. In this respect, psychologies in Europe and in America, which had been closely interrelated in the early period of their scientific histories, and subsequently became isolated during the predominance of behaviorism, were sustained by the Gestalt Revolution in their interaction, and have begun to reestablish their progressive corroboration.

I. CRITIQUE OF GENETIC PSYCHOLOGY
(School of Geneva)

The critique of the French Phase of genetic psychology (and especially the School of Geneva), from the methodological standpoint, is manifold, and we shall adopt the analytic approach in our discussion of the various phases of this critique.

(1) The problem of the *history* of the subject. The School of Geneva, while studying the psychological history of conceptions, ignores the educational history of the subject prior to his entering the laboratory. In fact, the psychologists of this School attend more to the biological history of the subject than to his psychological history: They always note with particular precision the chronological age of the subject, but they hardly fill a form concerning his past experience. Consequently, it is a paradox that the psychogenetic method is, at least in part, an ahistorical method, despite the systematically historical perspective of genetic psychology. This paradox is to be explained by the consideration that the School of Geneva is concerned with the description of the natural history of the genotype and not with the biographical history of the

phenotype. However, as we have noted previously, the trouble lies, not in the negligence of the social history of the subject, but in the occasional confusion of the concrete knowledge of the subject, as historical content, with his intelligence, as genetic content (For the detailed examination of this problem cf. Chapter 4:VII).

(2) The problem of *experimental parameters*. The main parameter of the psychogenetic method is "language", which, as the medium of rapport between the experimenter and the subject, serves to haul in the raw data of the experiment. Since the experimenter interprets the verbal responses of the subject, the value of this parameter is not absolutely constant, despite the critical standards which render the intrepretation relatively objective. Accordingly, as we have seen, parallel experiments performed by American psychologists, using nonverbal techniques, have yielded quantitatively different results (cf. Chapter 5:II). Nevertheless, the critical standards of the psychogenetic method, as they have been established by the School of Geneva, have succeeded to a high degree in the objective assessment of the linguistic data and their qualitative analysis (cf. Chapter 1:II for the examination of the psychogenetic method).

(3) The problem of the *analysis* of experimental phenomena. Despite the general coherence and comprehensive range of the genetic system, developed in the context of the School of Geneva, its theoretical analysis of experimental data suffers from sundry instances of inconsistency and formlessness. Suffice it to refer to two representative examples here: There is the well-known analysis of the evolution of the conception of physical causality into "17 varieties" of causal relations; yet, as we have demonstrated, these varieties can be reduced, by logical analysis, into *four types* of causality (cf. Chapter 4:IV). There is, again, the physicalist definition of the conception of time, in terms of spatial displacement and velocity, which is logically incompatible with the psychological perspective of the system; and, accordingly, we have distinguished between *time*, as a physical concept, and *duration*, as a psychological concept (cf. Chapter 4:III). Since we have examined these and similar points previously we shall say nothing more here.

(4) The problem of the *operations* and the *operator*. The researches of the School of Geneva, being confined to the experimental study of the *operations* of thought, neglect the organism as the *operator*. The critical problem involved here is whether the specific operations of intelligence can be adequately understood in isolation from the organic unity of the subject as an intelligent being. In our morphological study of

thought processes we have attempted to describe the relationship of the "contents of consciousness" to "consciousness". and again of the lower levels of the latter to its higher levels, in the effort to restore the psychological relationship between the cognitive operations and the operator (cf. Chapter 6:II). It is relative to this fundamental problem that we must again refer to the systematic work of F. J. J. Buytendijk (51) (52) (53), the senior psychologist of the School of Utrecht, which reveals two main critical strains with respect to the School of Geneva. Firstly, that in Piaget's system, the cognitive process is isolated from the other processes, with which it interacts, and then it is analyzed into the functions of intelligence (operations) and the faculty of intelligence (operator), the former being studied in isolation from the latter. The methodological significance of this problem consists in that, in configurational fields, the analytic understanding of the part is not possible without the synthetic comprehension of the whole. As Buytendijk (54: p. 78) has observed in the conclusion of a study of configurations in neurophysiology: "The study of parts does not supply ideas and concepts to understand the organism as a whole, but the experience derived from the whole shows the way to understand the functions of even the simplest parts". Secondly, that Piaget's system, being confined to the study of the logical operations of intelligence, has neglected the emotive processes which exist alongside of, and interact with, the cognitive processes within the organism. It is noteworthy that, while the primordial physiological and emotional variation between the male and female children determine their cognitive behavior, not a single paper concerning the ontogeny of emotions has come out of the School of Geneva (discounting Inhelder's (144) allusion to this relationship). We are obliged to assign the same degree of limited validity to the system of Piaget that we assign to its theoretical antithesis, Psychoanalysis, for the inversion of Piaget's critique of the latter applies to the former. It is beyond the scope of our undertaking to examine the state of emotions in the School of Utrecht (especially Buytendijk's four-dimensional theory) and suffice by observing that the ontogeny of emotion in the organism is a determining factor in the morphogeny of his cognitive conceptions. Elaboration and verification of this general viewpoint is to be found in the researches of M.J. Langeveld (School of Utrecht). Consider, for example, the effect of the subjective image of the self upon the objective conception of the world, beginning with the genesis of the image of the self as a function of the perception of one's body and bodily organs (e.g. autoreaction and heteroreaction to bodily characteristics and to bodily movements, like the hand and wrist movement and the difference thereof between boys and girls, described by Langeveld (195)), the introspective awareness of private feelings and emotions, and passing to the mediating operation of "projection", not in the psychoanalytic sense of the release and transformation of the suppressed emotion into the substitute object of perception, but in the genetic sense of the child's progressive unfolding and understanding of the world in the light of his personality and his image of his personality (cf. Langeveld (197)). Since eidetic self-formation, and the concomitant subjective projection, presuppose the relativity of the biosphere, and the corresponding psychosphere, Langeveld (194) finds reason to reproach the system of Piaget for its logical "biologism" and its biological "a priorism" despite its recognized empirical basis. Accordingly, the synthetic principles of psychogenesis formulated by Langeveld (196) represent a theoretical compensation for the limitation of the Piagetian system: For, the "principle of helplessness" (*Hilflosigkeit*), stating that the psychic need always exceeds the psychic potential, the "principle of security" (*Geborgenheit*), referring to the psychic convergence of the need and the potential, and the "principle of exploration" (*Exploration*), designating the surplus of the psychic potential for cognitive behavior, restore the psychic unity of the organism with respect to the interdependence of the cognitive and the emotive functions. It may be noted that, despite theoretical divergence between the two schools, agreement is to be found at the empirical level (Thus, for example, the phenomena of "genetic levels" recur in the two contexts as "psychogenetic stages" (Piaget) and as "psychic functions" (Langeveld)). We may conclude with the realization that the viewpoint of the School of Utrecht relative to the School of Geneva, is in the final analysis complementary when not critical. The same is true of the genetic *Ganzheitspsychologie* (especially F. Krueger (189)), which reinforces the discoveries of the former, and which we have referred to previously.

(5) The problem of the *qualitative methodology* of genetic psychology. Genetic psychology as well as gestalt psychology have been reproached by behaviorists for their employment of qualitative methods comprising of morphological analysis. And this criticism applies, not merely to the School of Geneva but equally to the School of Utrecht, for both, like the *Ganzheitspsychologie*, reject the priority of quantitative methods in their experimental investigations. For it is a characteristic of European psychology in general (excepting England), to relegate statistical

analysis to its proper secondary place in favour of the qualitative analysis, a characteristic which deservingly claims the credit for the empirical discoveries that have been made. The time is ripe, then, to state openly the essential problem which underlies this chronic controversy: Is the critical use of qualitative methods necessary and adequate for psychology, as a natural science, *or* should psychology confine itself solely to the use of quantitative methods? The investigation of the answer to this basic methodological problem, upon which depends the vindication of the methods of the genetic and gestalt psychologies, shall constitute the remaining task of the present chapter.

(6) The problem of *theory construction* in genetic psychology. Genetic psychology as well as gestalt psychology have been accused, by behaviorism, of representing a disproportionate ratio of theory to facts, that is, of containing a maximum of theory and a minimum of facts. Is this true, and if true, to what degree does it represent a methodological defect or an epistemological asset? The adequate answer to this critical question depends upon the investigation of the basic methodological problem that underlies the controversy: What is the nature of theory construction, in the context of natural science, and what is the logical function of theory? This investigation constitutes the remaining task of the present chapter.

Our assessment of the various phases of the critique of the School of Geneva is necessarily a cross-reference. The first pair of criticisms have been analyzed and evaluated previously (cf. Chapter 1:II & Chapter 4:VII). The middle pair of criticisms, however, are the most serious and, in the judgment of this author, some vindication can be found, either in the theoretical structure of the system of the School of Geneva, or in the annals embodying its empirical corpus. Yet, the current research of the School, instead of attempting to meet these basic problems, tends to wander off into the esoteric areas of mathematical logic and probabilistic biophysics, seeking far-fetched fragments of corroborative schemata, which provide but meagre nourishment for the gigantic plant of the *épistemologie génétique*, being rooted in the insufficient soil of the *psychologie génétique*, (cf. the *Études* (84)). As for the last pair of criticisms, which involve in their sweep all the phases of European genetic psychology as well as gestalt psychology, they are based upon, and therefore derive from, a set of presuppositions concerning: Firstly, the role of qualitative methods in psychology relative to quantitative methods; and, secondly, the place and function of theory in experimental psychology. This author shall attempt to write a defence of

European psychology, in the following pages, by an analysis of the validity of the assumptions upon which this class of criticism rests.

II. QUALITATIVE AND QUANTITATIVE METHODS

The relative values of qualitative and quantitative methods constitutes one of the basic methodological problems of the biological sciences. In the context of psychology, this problem may be stated as follows: Are the qualitative methods indispensable to the experimental methodology of psychology? That is, can psychology confine itself to the exclusive employment of quantitative methods and lose nothing? The methodological quarrel between behaviorism and positivism, on the one side, and gestalt psychology and genetic psychology, on the other, arises out of this basic problem. We shall attempt to provide a solution to this problem in terms of the principle of *methodological complementarity.* According to this principle, the qualitative and quantitative aspects of nature are equally real, and consequently the employment of both qualitative and quantitative methods are necessary and valuable in natural science (including psychology).

In his classic work Allport (7) has described the case of those methodologists who maintain that after all the aspects of nature have been described and explained in quantitative terms the work of science is completed. With such a mathematical conception of nature Allport disagrees; and, from an epistemological standpoint, so does this author. Does not, after all, the nature of psychological phenomena consist of being compounds of qualities? And does not the quantification of the various elements in science logically presuppose the qualitative differentiation of those elements? Are not the combination of qualitative analysis and quantitative analysis the standard procedure in all the biological sciences? If the obvious answer to these questions be a definite "yes", then those who advocate the exclusive mathematization of psychology are guilty of the methodological amputation of psychology. Psychology is a natural science—but from this fact it does not follow that psychology must be a physical science. Rather, as one of the biological sciences, psychology should construct its methodological model analogously to those of botany, zoölogy, or comparative anatomy.

Natural science studies natural phenomena. In other words (Allport (7: p. 17)): "Phenomena are the subject-matter of science." The difference between the natural sciences consists in that each science studies different kinds of phenomena at different natural levels. Psychology studies the structure and function of the cognitive and emotive processes of organisms. These psychological processes are manifested in two ways: First, in the introspective experience of the organism; second, in the interaction of the organism with the environment. All psychological processes involve a qualitative and a quantitative aspect. A complete knowledge of a psychological phenomenon consists of the description of its qualitative aspect and the measurement of its quantitative aspect. Psychology cannot afford to neglect either of these aspects without losing its empirical integrity. And if complete knowledge necessitates the employment of introspection and statistics alike, well then psychology must realize that these two methods of assessment are complementary. The main methodological point is that factor analysis and field analysis are logically compatible.

The argument against the exclusive reliance upon quantitative methods may be summarily stated: There is suffient evidence that qualitative methodology constitutes the primary tool of the biological sciences and quantitative methodology their secondary tool. An exclusive reliance upon *either* kind of methodology is capable of yielding only a partial and incomplete knowledge. In this respect behaviorism is more at fault than European genetic psychology which it assails. For as Allport (7: p. 628) has observed: "[Quantitative laws] are highly important theoretically as well as for practical purposes. But so are events and the structuring of events." Consequently, Allport (7) has suggested that the quantitative measurement of psychological phenomena is not enough; that their qualitative description constitutes an integral part of our knowledge; and that the objective of psychology as a science must be the determination of *qualitative laws* side by side with the *quantitative laws*.

The adoption of a one-sided methodology has adverse consequences for the advancement of psychology. The disadvantage of a purely qualitative methodology is that while it may reveal the patterns of phenomena it will not reveal their correlation coefficient. But the disadvantage of the quantitative methodology is even more serious: There is the grave danger that, by neglecting the qualitative aspect of phenomena, the quality of psychological research itself will decline. In an article concerning the evil consequences of uncritical quantification, Brower (46) has argued to the effect that: If it be granted that the task of science is the description and classification of phenomena, the discovery of laws, and the construction of a theoretical system, if this be the main task, then the statistical method impedes the progress of psychological science, by fostering the habit of "scatter thinking" in scientific research. Likewise Köhler (170), in the Wm. James Lectures delivered at Harvard University, defended the thesis that never will a problem of ultimate principle be solved as long as the qualitative aspect of phenomena remain neglected. As we have seen, in the beginning of this treatise, the methodology of European cognitive psychology is essentially qualitative and, in the indirect sense, introspective. Indeed, the family of the biological sciences are to be distinguished from the physical sciences, methodologically, in that in the former qualitative analysis occupies a primary place and quantitative analysis a secondary place, and that this order is reversed in the latter. Yet, behaviorism, which has introduced into American psychology the "pythagorean complex" (apt designation of Winthrop (367)), has also inherited the phenomenologically barren "data" from the Galton-Pearson tradition of "psychometrics". The acknowledged advantage of the statistical method is that everyone, given an average intelligence, can master it and apply it to the "raw data", thereby achieving the quantification. However, qualitative analysis is not as simple: It requires, beyond the training in the techniques, a high degree of intelligence and the corresponding capacity for insight into the manifestations of configurations and their ramifications. Behaviorism has earned for psychology the epithet of the "ape of physics"; but can the psychologists blame the public for this notorious reputation when the "standard" *Handbook of Experimental Psychology* (e.d. S. Stevens) does not contain a single chapter or even a single paragraph on the qualitative methodology of psychology? Yet, there remains the basic question that Woodworth (370: p. 7) has asked in his classic work on experimental psychology: "How could chemistry ever have become quantitative without first being interested in the various kinds of elements and compounds?" Not merely chemistry, but the whole family of the biological sciences, employ the twofold methodology of quantitative and qualitative analysis. Accordingly, the methods of trait-analysis and taxonomy are as indispensable to scientific research as the principles of factor- analysis and correlation coefficient. But if psychology were to follow the prescriptions of behaviorism, it should confine itself to quantitative assessments and ignore qualitative analysis altogether. It has been even maintained that all qualitative concepts can be translated into quantitative concepts: For example, "O" might represent the absence of a property, "1" its presence, "2" its recurrence, etc. But it is overlooked that such numerical representation necessarily presupposes the qualitative distinctions which constitute its logical precondition. The source of the trouble in both classical and contemporary behaviorism may be traced to their negligence of the phenomena accessible to qualitative analysis. It has been said that: "Every theory has its phenomenology except behaviorism" (Allport (7: p. 578)). If this be the case, and if phenomena constitute the content of phenomenology then we must agree with those European psychologists who describe contemporary behaviorism as "a psychology without a soul"! (cf. the critique of behaviorism in Chapter 5).

Throughout the present chapter, as well as in the preceding, we have referred to objective psychology. We have compared European genetic psychology with American genetic psychology; we have contrasted the methodology of gestalt psychology to that of functional psychology; and we have indicated that the methodology of objective psychology must represent a synthesis of qualitative and quantitative analyses. Let us, therefore, examine this matter directly if perforce briefly: What is the theoretical framework of objective psychology, that is, what are its epistemological postulates and methodological principles?

The theoretical framework of objective psychology may be outlined as follows:

(1) Psychology as a natural science belongs to the family of the biological sciences rather than the physical sciences. This conception is based upon the argument that there exists a fundamental affinity between the methodology of psychology and that of the other biological sciences, namely, the priority of qualitative analysis to quantitative analysis. (The conception of psychology as a natural science will be examined later in Chapter 10: I).

(2) The objective of psychology is to study, longitudinally as well as transversally, the structure and function of psychological phenomena. This study involves the analysis and classification of phenomena, the determination of natural types and of process correlations, and the explanation of phenomena with reference to inferred entities in the context of systematic theories.

(3) From the objective standpoint, psychological phenomena consist of the cognitive, emotive, and adaptive processes of the organism. Hence, the basic formula of objective psychology (S-O-R meaning that $R=f(S+O)$) implies that both the overt behavior as well as the covert psychological operations fall within the scope of psychology. (The nature of the phenomena of psychology will be examined in Chapter 9).

(4) The principle of methodological complementarity lies at the foundation of objective psychology, since it synthesizes, in one aspect, qualitative and quantitative analyses, and in another aspect, the longitudinal and transversal methods.

Objective psychology is represented in America in the form of objective functionalism which has evolved from its classical phase to its contemporary phase. There is a serious misunderstanding prevalent among European psychologists (excepting Germany) to the effect that American psychology consists of behaviorism. This gross misunderstanding must be dispelled forthwith: Behaviorism was, and remains, but a school of American psychology, and it is being overshadowed (especially since the rise of ethology) by the more influential school of objective functionalism which is both older and more recent. Classical functionalism, which was challenged by classical behaviorism, came to its renaissance as a result of the methodological critique of behaviorism by gestalt psychology. Roughly speaking, the period of classical functionalism terminated with the revolt of behaviorism, and the period of contemporary functionalism began with the revolt of gestalt psychology. Thus classical functionalism—represented by Wm. James, J. R. Angell, G. S. Hall, Wm. McDougall, and Morton Prince (E. B. Titchener, who opposed functionalism because of his own structuralism in the strict sense, would have preferred it at any rate to behaviorism)—underwent a gradual theoretical transformation. Accordingly, in contemporary times, the classic history of psychology (E. G. Boring), the systematic review of experimental psychology (R. S. Woodworth), the objective studies in genetic psychology (L. M. Terman, A. Gesell, F. Goodenough), the systematic investigations in comparative psychology (R. M. Yerkes, K. S. Lashley, E. C. Tolman, H. Klüver, H. F. Harlow, E. H. Hess), the original studies in theoretical psychology (F. H. Allport & E. Brunswik), as well as the comprehensive textbook in general psychology (D. Krech & R. Crutchfield), all have been written from the objective functionalist point of view.[1] The theoretical superiority of functionalism, relative to behaviorism, consists of the fact that its methodology represents a synthesis of qualitative and quantitative analyses. However, this methodological synthesis, be-

[1] The *Psychologische Institut* of the Universität Bonn, in the effort to determine the range of the influence of functionalism in American psychological scene, collected questionnaire data concerning the theoretical propensities of the Psychology Departments of the American colleges and universities (January 1956): The *combined number* of the psychology departments which classified themselves with "functionalism" and "eclecticism" was *greater* than those affiliated with "behaviorism" ("Eclecticism" may be interpreted, in this context, as a loose form of objective functionalism) (cf. B. Holzner (139)).

tween measurement and morphology, resulting in the class of objective studies to which we have referred, would have not been possible, were it not for the fact that contemporary functionalism, which became critical of the limitations of behaviorism, had already assimilated in its framework the concepts of gestalt psychology.

III. STRUCTURE AND FUNCTION OF THEORIES

Scientific knowledge, properly speaking, consists of a conceptually organized collection of facts. And, on the basis of the validity of this description, we can draw an analogy between the tree of science and the living plant itself. The conceptual contents and the factual data of science are interdependent in the way that the central system and the peripheral system of the plant are functionally interrelated. The methodological foundations of science, which determine the nature of scientific theories, result in a given category of working hypotheses rather than others. The experimental data, which constitute the raw materials of science, result in the nourishment of nascent hypotheses destined to bear further hypothetical fruits. It is thus that the metabolic cycle of science, from inductive generalization to deductive specification and conversely, renders both theories and facts the indispensable ingredients of natural science. Too, like the living plant, science has its diseases. Perhaps the most serious case in the pathology of science consists of the disturbance of the homeostasis of the elements of fact and theory within science. While there is the danger of theories not having sufficient empirical basis, there is also the danger of authentic science being reduced to the level of mere statistics. Paraphrasing Kant's dictum relative to epistemology, we may say concerning science: Without facts theories are empty, without theories facts are blind. It is far less fatal to the health of science if its data be inadequate than if it be harnessed by anomalous theories.

It has been said that in the introduction to the history of every natural science, especially the biological and psychological sciences, might be written: "In the beginning was the theory..." We shall inquire into the nature of theories: What is the structure and function of theories? In what sense theories may be regarded to be more important than facts? Since theories are logically prior, and empirically posterior, to facts which constitute the *data*, what are the criteria for the meaningfulness, and the validity, of theories? In the following pages we shall attempt to throw some light on the nature of theories, from a logical realistic standpoint, and vindicate this aspect of science which has become the popular subject of denigration in recent years. Our study of the nature of theories will be supplemented by a critique of the prevalent doctrine of operationism.

Theories, it will be maintained, are logically prior to experimental facts, in that they determine the methodological framework in the context of which the facts become scientific data; and they are empirically posterior to facts, in that by deriving general conceptions from the observation of data they ascend to a higher level of generality; so that, as a consequence, scientific facts may be said to be logically encased by scientific theories, the latter giving meaning to the former by providing them with an epistemological context. The function of theories may be sketched as follows:

(1) The general epistemological concepts, contained in the framework of the theory, determine the *methodology*, which in turn determines the experimentation of which scientific data are the product. Again, the construction of scientific theories, on the basis of the empirical data, generates new families of problems and hypotheses which guide further experimentation.

(2) The *explanation* of experimental phenomena with reference to a theoretical entity, and the explanation of the latter with reference to a higher level theoretical entity.

(3) The *prognosis* of phenomena, on the basis of the empirical record, by means of the conceptual transposition made possible by the theoretical framework.

(4) The *systematic integration* of scientific knowledge, empirical and theoretical, by means of a logical reconstruction of cognitive experience.

The theory is capable of these functions by virtue of its structure, as an abstract system of concepts and hypotheses, the former being the theoretical vertices which are bridged together by their hypothetical interrelationships. There are levels of concepts and hypotheses, determined by their degrees of generality (*Allgemeinheitsgraden*), resulting in varied theoretical integrations, ranging from lower levels to higher levels. When empirical hypotheses attain the degree of truth represented by their universality, they become expressions of natural laws, descriptive or explanatory. The logical analysis of the concept of *natural law* reveals four kinds: (a) *composition laws* (relative to the operation of classification), (b) *correlation laws* (relative to the probabilistic patterns of events), (c) *functional laws* (regulating the causal relationships), and

(d) *process laws* (regulating the ontogeny of biological and psychological operations). In experimental psychology, the causal explanation of phenomena, which involve the laws of functional dependence, necessitate the hypothetical assumption of theoretical variables. And, in the context of experimental psychology, the *intervening variable*, as an empirical concept which is directly verifiable and measurable, and the *inferred entity* (which nominalist writers call "hypothetical construct"), as a theoretical concept which is indirectly verifiable through the verification of its effects, are to be regarded as logically complementary. Accordingly, we shall say nothing here concerning the demands of operationism, which, considered from the angle of methodological complementarity, imply nothing but logical incompleteness. The generic conception of "organismic variables" consists of the intervening and hypothetical factors, the former being the empirically observable physiological and psychological factors, and the latter the unobservable psychological factors.

Theories may be regarded as *transcendent* to facts in two respects: First, in respect to the *generality* of theoretical concepts, in contrast to the particularity of empirical facts. For, from the logical standpoint, the intension of a concept is always more general than its extension. And it is in this sense that the concept of a given class transcends the percept of any given member of that class. Thus, for example, an experimental psychologist may have a perfectly clear conception of the "white rat" as a biological organism, with all its essential physiological and psychological traits, without having the vaguest idea of even the total number of these animals on the continent of America. Second, in respect to the *abstract nature* of the inferred entity (hypothetical variable) contained in the theory. For inferred entities are themselves not directly observable; and their reality is inferred on the basis of the observation of their various effects. Of the various cases of inferred entities in the natural sciences the following will be sufficient to illustrate our point: The concept of the "electron" in physics, of the "bond" in chemistry, of the "gene" in biology, and of the "engram" in psychology. And typically the scientist defends the status of inferred entities, in the face of the positivist protest which denies their value as well as validity, by a simple common-sense statement: "There is *something* here that has *these* effects, and we will call that bloody thing a Θ!" What logical positivism does in effect is to advocate the reduction of all scientific propositions to the horizontal level of x and y components, ignoring the fundamental explanatory Θ component. But positivism can achieve this suspect objective only at the high price of renouncing the explanation of natural phenomena altogether. In a study of the epistemological and ontological aspects of abstract entities, this author arrived at the conclusion that the degree in which we can afford to eliminate abstract entities in our theories is inversely proportional to the portion of the natural universe which we will be able to explain in principle (cf. Gobar (107)). Theories, then, not merely remain transcendent to facts, but also their great value lies in the fact of their transcendence. For related reasons, H. Feigl (88) at the Minnesota Center for the Philosophy of Science, has reopened the discussion of the problem of "existential hypotheses". And with respect to the epistemological status of theories, and the impossibility of their complete translation into the observational language even in principle, the reader may be referred to the recent studies of the structure of science (cf. Bibliography).

Theories are objective constructions which are susceptible of being judged valid or invalid. The main *criterion* of theories consists of this: Given two theories, the subject-matter being constant, that theory is best which displays a greater degree of logical consistency, a greater scope of explanation, and is confronted with less counter-evidence. Consequently, the theories of science are not social conventions. The construction of theories —consisting of the conception of the classificatory categories, the discovery of the inferred entities, and the formation of general hypotheses—is not an arbitrary matter but steps toward the discovery of the permanent patterns of phenomena. The patterns of phenomena constitute the subject-matter of natural science, and the latter must assume the *reality* of the former. Indeed, the assumption of the reality of its subject-matter constitutes the first empirical postulate of science (cf. James (146–I)). This postulate means, if it means anything, that *truth* is independent of our *knowledge of truth.* Yet it is sometimes maintained that theories are true because they work; for that is the only way that we know the truth of theories (Dewey (72)) But even if that were the only way to know the truth of a theory, the fact remains that the theory works *because* it is true; for if it were not true, it could have never worked. Logically speaking, the truth of a theory is not equivalent to its pragmatic effects, for it is possible for two different theories to have the same effect. According to the pragmatic theory, if $[(T_1 \rightarrow E) \cdot (T_2 \rightarrow E)]$ then $(T_1 = T_2)$; yet, logiccaly, $[(a \rightarrow x) \cdot (b \rightarrow x)] \not\rightarrow (a = b)$. It follows that truth is independent of its application: Pure science is permanently independent of applied science. The logical tragedy of contemporary times is that it tends to confuse these two things. To repeat a story from the recent history of physics (already related for the benefit of psychologists elsewhere): When Max Planck first formulated an hypothetical construct (the constant h), to explain discrepancies between the classical physics and the new observations (e.g. black-body radiation), physicists were sceptical in receiving a concept which appeared to have very little application; then Einstein formulated a general law for the photoelectric phenomenon using Planck's concept as a constant, and from then on the applications of this concept abounded, and today it is universally acknowledged as a great contribution to theoretical physics. The history of science is full of such cases, illustrating the logical priority of theory to practice and of pure knowledge to its application.

It is evident, from our brief review of the structure and function of theories, that theories are transcendent to facts: In the *ground* of experience lie transempirical categories, presupposed by experience, as *a priori* concepts; *beyond* the horizon of experience lie inferred entities, necessary for the explanation of the observable sense-data, as hypothetical concepts; and *above* the plane of experience lie classificatory concepts and explanatory laws, implied by experience, as logical reconstructions. "The concept relates to the object because and insofar as it is the necessary and indispensable presupposition of objectivization itself, because it represents that function for which alone there can be objects, for which there can be constant and fundamental unities amid the flow of experience," writes Cassirer (60: pp. 317 & 384), and again, "The logical world, the mathematical world, and the world of empirical objects: all have a common foundation insofar as they are all rooted in one and the same primal stratum of pure relational forms. Without these forms, without categorical determinations such as unity and otherness, identity and difference, it would be equally impossible to conceive of a totality of logical concepts, an aggregate of mathematical objects, or an order of empirical objects." However, the transcendence of theories, relative to experience, implies that they possess, not merely a logical form which is far more general than the concrete nature of facts, but also, in some fundamental sense, a kind of "surplus-meaning". What, then, is "surplus-meaning"?

From the realistic standpoint, "being is synonymous with being constituted", structure constitutes the essence of meaning, and all knowledge is essentially structural. We may, then, describe the structural *principle of meaning* as follows: An object of awareness, perceptual or conceptual, which possesses a configuration, concrete or abstract, possesses meaning, irrespective of the degree in which it is comprehended by the subject. The body of meaningful knowledge consists of perceptual meaning plus conceptual meaning; and the latter is what is left over after the former is subtracted from the total meaning. The significance of the classical context theory of meaning lies in the fact that the context partially determines the form of the object. Corresponding to the two kinds of meaning may be distinguished two levels of experience: Prehension (perception of phenomena) and insight (apprehension of types). If psychology accepts the principle of structural meaning, then it must reject the positivist "principle of verification" on the ground that it limits the meaning of meaning to perceptual meaning ignoring conceptual meaning altogether. Furthermore this dogmatic principle is perennially involved in a vicious circle: The meaning of a hypothesis presupposes verification, and verification presupposes the meaning of the hypothesis (for how could we begin to verify without first knowing the meaning of what we verify?) The concept of verification then must be *redefined*, on the basis of the principle of structural meaning, in terms of structural realization.

The logical argument for "surplus-meaning" may be stated as follows: Either theoretical concepts have surplus-meaning or they do not have surplus-meaning. If they have surplus-meaning then they can have a function in science which facts cannot have; but in that case conceptual meaning cannot be reduced to factual meaning. If they do not have surplus-meaning, then conceptual meaning can be reduced to factual meaning; but in that case concepts cannot have any special function in science. The logical dilemma which this argument presents is this: We must choose between physical reductionism and theory construction, for the two are incompatible with each other. We cannot consistently utilize the theory, which performs a function that facts cannot perform, and at the same time insist that the theory is nothing more than the aggregate of corresponding facts. If theories were nothing more than facts, then they would perform no function beyond facts. There are other grounds on which the surplus-meaning of theoretical concepts might be defended; and the reader may be referred to the article on the construction of models in psychology by the Scandinavian psychologist R. Rommetveit (307).

The doctrine of operationism—which is the catalyst of physical reductionism—denies the necessity of "surplus-meaning". According to operationism, concepts must be defined operationally in terms of physical operations exclusively. "The concept is synonymous with the corresponding set of operations" (Bridgman). Pratt (288) has remarked that this doctrine would like to eliminate "ninety percent" of our psychological concepts. And Allport (7: p. 54) has written: "To sacrifice all experience-content for a methodological canon, though such a rule may be highly useful in other connections, is to throw out the baby with the operational bath... One thing, perhaps, that the stricter operationists have overlooked is that phenomenological experience is still *experience* and as such belongs in the domain of science as legitimate content for study." The cradle of operationism was, of course, physics not psychology. It is on this physicalist basis that operationism constitutes an "unholy alliance" between logical positivism and contemporary behaviorism. We shall outline here the logical critique of the doctrine of operationism (The definitive examination of operationism is written by A. C. Benjamin (31)):

(1) Operationism and prognosis are logically incompatible. For, as H. Poincaré has remarked, "without generalization, prediction is impossible". Operationism destroys generalization by defining the concept in terms of particular operations. But the concept is *not* a particular operation, but the *general structure* of a set of operations. The difference between an operation and a concept corresponds to the difference between the Ø-gestalt and the Θ-gestalt. The generality of the concept consists in that the concept is the invariant of transposition. And this generality is the necessary condition of prognosis. Thus operationism blindfolds science with respect to its foresight.

(2) Operationism suffers from an inherent paradox. If the concept be defined in terms of an operation, then two *different* operations should never yield the *same* concept. Thus the concept of length will not remain constant: The tapeline length of a given area and the trigonometric length of the same area will not be equivalent. And to equate these two different operations would imply the existence of a transoperational concept; for the *reference* of the terms of this operational equation would be the *same concept* (cf. Lindsay (200) and Benjamin (31)). Indeed operationism, carried to its logical consequence, results in a subjective epistemology: The operation is said to determine the nature of reality, and the subject performs the operation; consequently, two subjects, with different sets of operations, will not know the same reality but shall remain confined to their isolated worlds respectively. And it is ironic that the allegedly objective and public method of operationism should become the progenitor of an epistemological solipsism that outdoes the most subjective of idealisms.

(3) Operational definition appears to be neither the necessary condition not the sufficient condition for meaningful concepts. Let us suppose that an experimental psychologist, having forced the white rat to wet the floor of his cage under emotional stress, attempts to define (operationally) the emotional state corresponding to this behavior and calls it "anxiety"; and let us suppose that another psychologist, in another laboratory, observing the same behavior of the rat under similar conditions, attempts a parallel operational definition and calls the emotion "fear"; further, let us suppose that the two wild rats, during successive trials ceased from urinating but vomited instead; then our two operational scientists will be left with the following set of problems (unresolvable in the context of *their* methodology): (a) How to distinguish between two qualitatively different emotional states when their behavioral effects are contingently similar? (b) How to prove the persistence of an emotional state when its behavioral manifestation varies within the given context? Indeed operationism, which is considered by its adherents to be an antidote to verbalism, is itself very well capable of generating verbal terms without meaning. A good example may be taken from Benjamin (31): "The concept of *age* as applied to a man certainly has both operational definition and reference to reality; so also does the concept of *height*. Now suppose, following the suggestion of Hempel, I multiply a man's height by his age, getting a number which I then call his *hage*. This is operationally defined, but does it have any reference to reality?"

The way out of these logical pitfalls is not the way operationism has sought to follow. Namely: "Operationism, in common with the closely affiliated position of logical positivism, began with a point of view which was perfectly clear-cut but obviously absurd. Then, through revisions and reformulations it achieved a greater and greater generality, with an ever increasing ambiguity" (Benjamin (31: p. 66)). The main defect of operationism is that it confines itself to the *correspondence aspect* of truth and ignores the *coherence aspect*. There is an element of truth in operationism, namely that theories must correspond to facts, but this element can be preserved perfectly well in a realistic philosophy of science free from the perils of operationism. A realistic philosophy of science recognizes the necessity of both the "correspondence" of theories to facts as well as the "surplus-meaning" of theories. The principal point is that factual verification as well as theoretical construction, "factual checks" as well as "ideal concepts", perceptual meaning as well as conceptual meaning, are simultaneously necessary in science.

Psychologists should be wary of the uncritical acceptance of a piece of methodology from physics, especially when its status within physics itself be subject to controversy. Indeed, as J. R. Oppenheimer (244: p. 134f) of the Institute for Advanced Study has observed, "The worst of all possible misunderstandings would be that psychology be influenced to model itself after a physics which is not there any more, which has been quite outdated... This is quite a pack of ideas that we always use: individuality, wholeness, the subtle relations of what is seen with how it is seen, the indeterminancy and acausality of experience. There is an enormous work of analyzing, of recognizing similarities and analogies, of getting the feel of the landscape, an enormous qualitative sense of family relations, of taxonomy." Psychology must always reevaluate, in its own context, any method adopted from the other natural sciences. In the meantime it is to be hoped that methodological authoritarianism might learn the lesson of toleration from the fact that its own results are wrought with logical handicaps. We may end this discussion with the words of a functional psychologist pronounced before the American Psychological Association (Allport (8: p. 26)): "My plea, therefore, is that we avoid authoritarianism, that we keep psychology from becoming a cult from which original and daring inquiry is ruled out by the application of one-sided tests of method..."

Taking as our startingpoint the epistemological postulate of Wittgenstein (369: prop. 2.1), that "We make unto ourselves pictures of facts", we may describe the essential function of science as the construction of theoretical systems. These systems are constructed on the basis of the qualitative and quantitative analyses of phenomena. Accordingly theories provide matrices, within which factual data find their logical places, and on the basis of which the explanation and prediction of phenomena are rendered possible. And since facts, without concepts, remain as mere material for analysis, scientific knowledge is always conceptual. The pattern of theory construction, throughout its variations and transformations in different contexts, remains constant:

(1) The *analogical model*, derived from a given scientific paradigm, is redefined in the new context.

(2) The basic *postulates* of the theory.

(3) The *logical linkage* of the "theoretical laws" with the "experimental laws" by means of hypothetical theorems.

Two consequences are to be noted: Firstly, that the analogical model determines the ontological level and the epistemological scope of the theory. And secondly, that the theoretical framework of the scientist determines his methodology, which in turn affects the very experiments themselves. Hence the authentic scientist must always be something more than a mere statistician. Indeed, nothing is more wasteful than the extravagant expenditure that goes into the commonplace statistical assessments, in the name of research, without any theoretical starting-point and any theoretical result.

But is it really possible to have a science without theory, that is, is theoretical construction absolutely necessary in science? To the question, "Are theories of learning necessary?", Prof. Skinner (321) of Harvard University has given a radically negative answer. It is clear that, if theories of learning were dispensable, then the other cognitive theories would be equally dispensable, for Skinner and his followers abjure theory *qua* theory: They wish to obtain nothing less than the paradoxical state of *science without theory*. Skinner's argument consists in that theories do not affect the experimental design and are consequently superfluous. But, as we have noted elsewhere, the theoretical perspective does determine the methodological approach which in turn affects the experiment. To overlook this fact is to allow statistical short-sightedness, which is concerned with data accounting, to prevent us from seeing the theoretical significance of the data. Indeed, the enemies of theory in science display a naïve conception which fails to distinguish between two epistemological levels: Firstly, there are *microscopic theories* which are constructed at a lower phenomenal level than their explicanda (e.g. a physiological theory might explain psychological phenomena with reference to neural factors). Secondly, there are *macroscopic theories* which are constructed at a higher phenomenal level than their explicanda (e. g. a psychological theory might explain the phenomena of learning with reference to the concept of equilibrium). Now the rejection of microscopic theories, for any reason whatever, does not by any means warrant the rejection of macroscopic theories within a given science. In the case of psychology it is highly doubtful whether its complete independence from physiology is possible, or even desirable, since the two sciences are complementary, the knowledge of the physiological as well as the psychological aspect being the necessary conponents in the objective study of human nature. And these matters are not improved by the fact that Skinner states his case against the macroscopic theories (psychological constructions) but defends it by repudiating the microscopic theories (physiological constructions). This illicit shift in meaning leaves the case against theories without any logical ground whatever. Since already several critical studies of this controversial issue have been made, with which we are essentially in agreement, we shall say nothing more about the matter here (cf. Scriven (315) and Ginsberg (106)). One wishes that one could say, that perhaps Prof. Skinner did not really mean to give the antitheoretical impression which his followers have projected, but his own sundry statements leave little doubt as to the contrary. And even if the doctrine of "operant operationism" remains, tarnished as it is with amphibology, an idol of the den, it still dazzles a sufficient number of students who have forgotten the fact that this brand of radical behaviorism is itself, in the final analysis, another theory among theories. And when the Skinnerian epigram, i.e. "Theories are fun!", will be remembered it will be for its sensationalism rather than for its meaning. The objective of science, namely constructing a conceptual transcript of reality, is more serious and revered, and this spirit of seriousness and reverence is the necessary precondition of all worthy discovery.

Concluding Note

The main principles that we have described in the present chapter, namely that of "methodological complementarity" and that of "structural meaning", have been entailed by the very nature of scientific knowledge in the context of objective psychology. And our realistic thesis, concerning the transcendent nature of theories, is corroborated by these principles. It may now be noted that both principles presuppose an epistemological framework without which they could neither be formulated nor related to each other. We shall, then, undertake the examination of the epistemological groundwork of objective psychology in the next chapter. It is thus that experimental phenomenology leads to the analysis of methodology, and the latter, in turn, to epistemology.

CHAPTER 9

EPISTEMOLOGICAL FRAMEWORK OF PSYCHOLOGY

A chronic controversy persists, in the context of the contemporary philosophy of science, over the problem of the metaphysical presuppositions of natural science. Our examination of the experimental phenomena of empirical psychology has led us to the conclusion that, as a natural science, psychology is grounded in epistemological foundations which provide a theoretical basis for its methodology. On closer inspection it will be seen that the epistemological foundation of science, considered as an integrated *a priori* schema, necessarily has a trans-empirical (metaphysical) nature; and that our conclusion is not to be limited to psychology alone, but applies to the whole family of natural sciences, insofar as the various sciences have a common logical structure which gives them their objective unification. Accordingly this author agrees with the observation of Cassirer (60: pp. 22 & 448), that, "After all the progress made by epistemological analysis in the field of modern physics, it is scarcely open to serious doubt that the knowledge of the world of things is bound up with very definite theoretical presuppostions and conditions, and that consequently the objectivization progressively effected in the natural sciences is always at the same time a process of logical mediation," and his conclusion that, "We consider the world of exact science not as the beginning but as the end of a process of objectivization, whose roots reach down into other and earlier strata of formation." In the last analysis, the methodology of science is constructed within an epistemological framework, since the adoption of scientific methods is invariably determined by the conception of the nature of scientific knowledge and the criteria thereof. The most fundamental presupposition of empirical psychology, concerning the reality of its subject-matter, consisting of a realm of phenomenal configurations existing within the matrix of qualitative dimensions, and the epistemological possibility of an objective knowledge thereof, results in an epistemological problem concerning psychological phenomena: What is the nature of psychological phenomena and in what respects are they to be differentiated from the phenomena of the other natural sciences, and why are the methods sufficient for the investigation of the latter not adequate for the study of the former? In the following pages we shall attempt to throw some light upon this and related problems. Our discussion will be mainly based upon the epistemological aspects of the genetic and gestalt psychologies (as well as functional psychology) but it is expected that our results will be general enough to extend to the science of psychology in general.

I. THE PHENOMENA OF PSYCHOLOGY

Objectively described, *psychology* consists of the experimental science of the cognitive and emotive phenomena (which lie *behind* the adaptive behavior and constitute the psychological explanation thereof), and belongs to the family of the biological sciences, in which the qualitative analysis occupies a primary place relative to the quantitative analysis. And since natural "phenomena" constitute the subject-matter of psychology, the epistemological problem concerning these may be stated as follows: What is the nature of psychological phenomena, in general, and how are they different from the phenomena of the other natural sciences? From the epistemological standpoint, a *phenomenon* (φαινόμενον) is the configurational being which, as an element of Being, appears in the cognitive experience of the subject. Hence, in the context of science, a phenomenon is any observable "fact" susceptible of description and explanation. Epistemologically, all phenomena are observable for, not only the realm of "physical facts" but also the realm of "subjective events", constitute the data of cognitive experience. However, logically speaking, all phenomena are equally "real", for they are the manifestations of the same substratum of Being, and there is no logical ground for regarding some phenomena to be in any sense more real than others. It appears, at first sight, as if the generic concept of fact involves, as its subcategories, the class of "physical facts" and the class of "psychological facts". But further reflections reveals that the class of psychological phenomena in fact coincides with the class of physical phenomena, epistemologically, for the "physical object" is known by the medium of the "psychological object".

Accordingly, we shall assume the *principle of phenomenal mediation*, which states stating that: Our knowledge of psychological phenomena is immediate, and our knowledge of physical objects is necessarily mediate, since the latter are to be known through the medium of the former. The psychology of perception provides evidence for this principle: For perception is a constructive process and not a passive photographic process (cf. Chapter 3). In the light of modern psychology, the "double myth" of empiricism, to the effect that we have a direct knowledge of the physical object (myth of the given) and that cognition is a passive process (myth of the empty-mind), can no longer be maintained. It follows that our image of the object is never a perfect copy of the same. Of course, we shall never really know to what extent the image is a distortion of the object; for we shall never meet the object itself face to face, so to speak. In cases where we "correct" a given perception by an independent physical measurement—e.g. correction of an optical illusion by tapeline measurement—we are really correcting one perception by another perception. The object itself, which we never meet directly, is never compared with our image of the same. Generally speaking, given the psychological phenomenon, we *infer* the existence of the physical object behind it. As Strasser (330: p. 61) has observed: "Human subjects discover the objectivity aspect of reality by means of an objectifying approach." And the negligence of this epistemological principle would involve the subject in the predicament of the "fallacy of misplaced concreteness" as it has been diagnosed by A. N. Whitehead (365). We perceive only what appears before us as a phenomenon; everything else is inference. While radical phenomenalism remains sceptic with respect to the validity of transphenomenal inference, realism bases the validity of this inference upon the general fact of phenomenal constancy. Upon this logical ground, then, natural science can build its experimental station and engage in systematic observation and hypothetical inference concerning nature. For, as it has been noted by Cassirer (60: p. 60): "The essence of perception is defined according to its objective validity. But thereby a specific interest of cognition is injected into the exposition of perception. To understand it now means to apprehend it as one link in the structure of the knowledge of reality—to assign it to its appropriate place within the totality of the functions which form the basis for the relation of all our knowledge to the object." This is not mere conjecture concerning the process of perception, and the resulting operation of objectivization, for it is precisely this functional interdependence of perception and cognition that contemporary experimental psychology has striven to demonstrate.

Experimental psychology has demonstrated that there are colors in nature that we never see, and that there are sounds that we never hear. Our color perception is confined to the range of 400-800 millimicrons wavebands approximately; and the range of our auditory perception is confined to sound waves between 20-20000 cycles per second frequency approximately. We never see the ultraviolet and the infrared shades of color (and we must see Röntgen rays in the dark with dark-adapted eyes); nor hear the cries of night-blind bats in the dark. The world, as it appears to the lowly frog (a colorless space of displaced shadows), or to the tiny bee (a world seen from the perspective of a displaced color spectrum), or even to the domestic dog (a sensory universe richer than that of his master), is not the world that appears to us, and could never be, being determined by our *a priori* framework of perception. We are spectators, this side of the epistemological screen, and feel but a fleeting phase of events bringing, in natural disguise and in codified symbolism, word of the constant entities and equilibrate forms of the real external world. We need never go the legendary forest to see whether the falling tree made a sound before our arrival: The philosophical riddle of Berkeley no longer astonishes us, as it once did, before Kant and before modern psychology. We cannot see things, when they are there and we are there, as they really are, outside our cognitive framework of objectivization, which gives them their phenomenal form.

From astronomy we learn that many a star, which we look at every evening, has ceased to be many years ago. Is it not very strange that we now perceive a physical object that no longer exists? It appears that the perception of stars involves an epistemological paradox. It is true that the life-span of this paradox will be short; that we continue to perceive the extinct stars bacause they disintegrated before their last rays reached us (despite the remarkable velocity of light); and that when these last rays have run out we shall cease to perceive those stars. Nevertheless the fact remains that there is a period of time, however transient, during which we do have a glittering image of a nonexistent physical object. Psychology, then, must treat perceptions of this nature exactly like other perceptions. The difference between illusory and veridical perceptions does not lie in their own reality, but in the reality of the object *behind* them. Phenomenologically speaking, as Paul Weiss (354) has observed, the temporally distant stars are as contemporaneous with us as the nearest objects on earth. The case of the distant stars is really not different in principle from other psychological phenomena: The phenomenon of parallax (discrepancy of objects as a function of perspective) and of the horopter (unification of images as a function of perspective) both indicate the epistemological gap between the physical and the psychological.

The "pure stuff of experience", to use the phrase of James, flows beneath the phenomenal surface. And the only indicator of its movements is our system of sensations. For this reason the comparative psychologist H. Piéron interprets sensations as the "biological symbols" of external events. In the same sense our perceptions may be regarded as the "psychological symbols" of our sensations. But how very different is the character of this symbolic representation from the sensational doctrine of classical empiricism or from the empirical atomism of modern positivism! This difference stems from the contrast between phenomenology and physicalism.

The classic case of the contrast between the phenomenological perspective and the physicalist perspective is provided by the conflicting theories of colors. Goethe's theory of colors—which in contrast to Newton's theory of colors refused to identify colors with wavelengths—was the first serious attempt to renounce the identification of the qualitative and quantitative aspects of phenomena. This epistemological observation constitutes the most valuable part of Goethe's theory; and those who have quibbled about the details of this theory have failed to see the forest for the trees. It is of course quite natural that physicalists (e.g. Helmholtz) should have failed to find anything of value in a piece of phenomenological research. And while physicalism retarded the advancement of psychology, Goethe's theory of morphology and hypothesis of metamorphosis inaugurated the phenomenological perspective in the biological sciences. As W. Heisenberg (130) the theoretical physicist has explained, the essential difference between the Newtonian and the Goethean theories lies in that they describe "two entirely different levels" of reality. Newton was concerned with numbers and wavelengths; Goethe with colors and forms. At the physical level, we can afford to disregard the psychological phenomena in general (even though there are exceptions, for example, the problem of "personal equation" in astronomy); but at the psychological level we must deal with these phenomena themselves for they constitute the very *raison d'être* of psychology as a natural science.

However, from the fact that all phenomena are subjective, in the final analysis, it does not follow that all knowledge is subjective. For one thing, besides the knowledge-of (perception) there is the knowledge-about (conception); for another, besides subjectivity there is intersubjectivity. Accordingly, the two kinds of *subjectivity* involved are to be distinguished: (a) There is the *psychological subjectivity* resulting from the fact that the perception of phenomena is a function of organismic variables which vary relative to subjects. (b) There is the *epistemological* *subjectivity* resulting from the fact that the perception of phenomena takes place within the framework of the natural laws of perception which vary relative to species. Science can avoid psychological subjectivity but, as philosophy has discovered since Kant, it cannot avoid epistemological subjectivity. This, however, is sufficient to guarantee the intersubjective objectivity of science. How is then intersubjective knowledge possible when all experience is subjective in a twofold way? Two subjects can never experience each other's experiences without modification. But from this it does not at all follow that the experiences of two subjects can never have anything in common. For, while different subjects never experience, strictly speaking, the same *phenomenon*, they do experience the same *form of* phenomena. This may be expressed in the terminology of gestalt psychology, by referring to the impossibility of the recurrence of the same Ø-gestalt and the possibility of the recurrence of the same Θ-gestalt. Thus the intersubjective operation of *Verstehen* is possible on the basis of configurational cognition.

The problem of the nature of the "phenomenon" is intricately bound with the problem of the nature of "knowledge". The *principle of cognitive duality* which we shall maintain, with respect to the nature of knowledge, may be stated as follows: "Knowledge" is a generic concept which represents two types of cognition, that is, perceptual cognition and conceptual cognition. The former consists of the perception of the structure of a given phenomenon, and the latter of the apprehension of the structure of a class of phenomena. In this sense all knowledge is essentially structural: In the one case it is concerned with concrete structures, in the other case with abstract structures. This epistemological distinction between "perceptual knowledge" and "conceptual knowledge" corresponds to the vaguer, traditional, distinction between "knowledge-of" and "knowledge-about". While the English language has never formed a corresponding terminology, this has been available in German and French: Thus *wissen* and *savoir* have a parallel semantic content with *kennen* and *connaître* respectively. Of course this philological dichotomy may be traced to the classical Greek terminology where ἐπιστήμη (knowledge proper) was to be distinguished from γνῶσις (empirical acquaintance). Knowledge proper, then, consists of conceptual knowledge. As H. Feigl (87: p. 77) has written: "Knowledge proper is always conceptual. This insight is an important point of agreement between such otherwise divergent recent philosophers as Poincaré, Bergson, James, Dewey, Russell, Eddington, R. W. Sellars, C. I. Lewis, Schlick, Wittgenstein, and Carnap." One may add the names of other thinkers: A. N. Whitehead, E. Husserl, M. Heidegger, N. Hartmann, E. Cassirer, F. J. J. Buytendijk, W. Köhler, J. Piaget, H. Spiegelberg, S. Strasser, and H. H. Price, not to mention the conceptualism of the classical philosophers. Since conceptual knowledge consists of the comprehension of the logical structure of phenomena, concepts are characterized by a corresponding logical structure, which is attained in a twofold way. There is, firstly, the process of "abstraction" of which the first step is the analysis of the concrete properties of a series of phenomena and the last step the synthesis of their abstract morphology (cf. Chapter 7: I). There is, secondly, the process of "inference" which, commencing with the observable effects and traces of unobservable factors leads to the discovery of abstract entities. The epistemological path that leads from perception to conception consists of the constancy and recurrence of phenomena. The constancy of phenomena in turn may be explained with reference to the constancy of the objective structure of the external world and that of the laws of perception. For it is on the basis of the constancy and recurrence of phenomena that we are able to infer the reality of a permanent external world. It may be noted, however, that the duality between the "phenomenal realm" and the "physical realm" does not indicate a corresponding contrast between "appearance" and "reality", but rather a contrast between two different realms of the same reality. The contrast between the sciences of physics and psychology consists, not in the fact that the one studies appearances and the other realities, but in the fact that they study different aspects of a larger reality. All natural sciences have their own brands of appearances and realities. Behind its observable phenomena, physics has its electron and electromagnetic field; chemistry its chemical bond; biology its gene; and psychology its engram. Consequently, to interpret the phenomena of one science as the epiphenomena of another is to overlook the epistemological duality inherent in the nature of science.

We have outlined two basic principles of a realistic epistemology: The principle of *phenomenal mediation* and that of the *duality of cognition*. The historical roots of these principles are traceable in psychology, from Brentano and Hering to Wm James and Köhler; in philosophy, it is traceable to German phenomenology. The conception of psychology as a "propaedeutic science" originated with Brentano who observed that the "objects" of other sciences were to be known *through* the "objects" of psychology. James defended the phenomenological method by means of his "radical empiricism" in general, an empiricism which took account of the elements as well as their relations in experience, and by means of the "introspective method" within psychology.

We may now state the theoretical import of the above epistemological principles for the logic of verification. If it be the case that there are two types of knowledge, and if in both cases the nature of knowledge is essentially structural, then the meaning of "meaning" can be reformulated in the light of these hypotheses: We shall state, as the principle of *structural meaning*, that any datum possessing a structure, whether perceptual or conceptual, therewith possesses meaning, insofar as the given structure is prehended by the subject. The classical contextual theory of meaning does not contradict, but entail, this principle, for only to the degree that the structure of the context permeates that of the object does the former contribute to the meaning of the latter. Accordingly, a conception is meaningful if it refers to a concrete or an abstract configuration. From this it follows that we must adopt the principle of *realistic verification*: That is, any datum which possesses a structure (perceptual *or* conceptual), and therefore a meaning, constitutes a fragment of Reality, and cannot be excluded from the repertoire of authentic philosophy. Generally speaking, the body of meaningful knowledge consists of the sum of perceptual meaning and conceptual meaning. The true significance of the "contextual theory" of meaning lies in the fact that the context partially determines the form of the object. However, the epistemological problem of the nature of the "context" of experience, as the correlate of the experienced "text", remains to be elucidated from the standpoint of phenomenology. There is, of course, the psychological analogy of the "figure and ground"; but the "context" of experience involves a wider range of meaning than the perceptual "ground". For we must distinguish between the two kinds of contexts, the "subjective" and the "objective", both of which contribute to the partial determination of the form and meaning of the configurational object. We have already reviewed, in previous chapters, the various manifestations of the "objective context" (e.g. the "Purkinje phenomenon" in the perception of chromatic colors and the "ratio phenomenon" in the perception of achromatic colors), as well as of the "subjective context" (e.g. the phenomena of "Einstellung-effect" and "functional stereotypy"), in the context of experimental psychology (cf. the researches of Wallach (348) (350) with respect to the former, and of Duncker (78), Fuchs (100), and Ferdinand (91) with respect to the latter). Epistemologically speaking, then, the "context of experience", encasing and sustaining the phenomenal object of experience, as it were, overwhelmingly molding its cognitive contour and pervasively imbuing its affective coloring, contributes to the configuration of the object, and therefore its meaning, in a profound sense. It follows that the vagueness of the context, in the light of which the text is to be held, and the *lecture de l'expérience* to be made possible, will result in a systematic *Verschwommenheit* of the text. And the resulting prehension of ambiguity is to be considered the critical factor in the psychological conversion of the "cognitive meaning" into the "emotive meaning" of the given object. In any case, the transempirical context of the empirical object, whether as the "context of experience (Spiegelberg (327)), or the "thematic field" (Gurwitsch (117)), or yet the "phenomenal horizon" (Heidegger (129)), determines the configuration of the object.

If psychology, as an empirical science, is to maintain the principle of structural meaning, it must reject the positivist interpretation of verification, on the ground that the latter arbitrarily limits the the meaning of meaning to perceptual meaning and ignores conceptual meaning altogether. Again, the same viewpoint arbitrarily limits the meaning of perceptual meaning to public verification and ignores the epistemological contents of introspection. In either case, the positivist principle is perennially involved in a vicious circle: The meaning of a hypothesis presupposes verification, and verification presupposes the meaning of the hypothesis (for how could we begin to verify without first knowing the meaning of what we verify?). In a profound sense, positivism cannot explain the possibility of science in general: For *in* a purely physical universe there is not a logical place for a theory *about* the same universe. That the knowledge of meaning is always presupposed, in all the undertakings of scientific research, has been independently observed by S. Strasser (330). Accordingly, Strasser considers "meaning" as something "ultimate" in the sense that it is always presupposed by verification. If what is to be verified had no meaning, then verification would be a logical impossibility, and therefore meaning is logically prior to verification. We have attempted to describe the nature of "meaning" in terms of the concepts of structure. Accordingly, the concept of verification, in the context of contemporary philosophy of science, stands in need of a redefinition from the standpoint of the realistic epistemology. And the redefinition attempted here bears equally significant implications for the methodology of psychology as well as of natural science in general.

II. IS PSYCHOLOGY REDUCIBLE TO PHYSIOLOGY?

The problem of reductionism is logically traceable to the problem of explanation in science. For the doctrine of reductionism basically seeks to describe the logical conditions for a well-defined type of explanation: Namely, the explanation of the phenomena of a given science (*reduced science*) with reference to the data of another science (*reducing science*) despite the phenomenological gap between them. We shall begin, then, with a logical examination of the nature of explanation in psychology, and subsequently attempt to demonstrate that reductionism is neither a necessary nor a valid doctrine with respect to the phenomena of psychology. It is not valid, we shall argue, because it is beset by grave logical defects that render it unreasonable; and it is not necessary, because an alternative line of explanation concerning the phenomena of psychology is obtainable.

Of the natural sciences psychology especially is confronted with the problem of the duality of its subject-matter. There is, firstly, the aggregate of observable data of overt behavior; and there is, secondly, the aggregate of unobservable psychological operations within the organism. Accordingly, the perennial problem of psychology has been the explanation of how the latter is to be related to the former. Hence, Boring (39: p. 620), surveying the history of the subject, writes: "Does psychology deal with the data of consciousness or the data of behavior or both?" From the methodological standpoint, the descriptive analysis and comparative study of the behavior of organisms and its variants is at least directly possible; but the explanation of overt behavior, with reference to covert psychological processes, appears to be a task of far greater difficulty and complexity. These psychological processes, unlike the behavioral data, can hardly be pinned to the dissecting-table of direct observation. In the face of this methodological problem, three alternatives appear to be possible: First, the systematic negligence of the covert psychological processes altogether and the confinement of investigations to the study of overt behavior exclusively (This is the alternative adopted by the S-R behaviorism with its conception of the "empty-organism"). Second, the thesis that the proper explanation for the behavior of organisms is to be found in sciences other than psychology (This alternative is adopted by logical positivism with its conception of the "unified science"). Third, the inference of a network of psychological processes within the organism and the explanation of its behavior on the basis of the correlation of the former with the latter (This is the alternative adopted by gestalt psychology, genetic psychology, and functional psychology, with their parallel conceptions of psychophysical parallelism). We shall say nothing here about behaviorism, which we have critically discussed previously; instead, we shall confine our discussion to the latter kinds of explanation.

From the logical point of view, the two basic types of *explanation* in psychology may be described as follows:

(1) *Analogical explanation*, where a covert system of psychological processes is inferred from the observation of the overt patterns of behavior, and the latter are then explained with reference to an "analogical model" at a different phenomenal level. This type of explanation is generally utilized by gestalt psychology and genetic psychology.

(2) *Homological explanation*, where a "homological model" is constructed at the same phenomenal level as the patterns of overt behavior, and subsequently the latter is explained with reference to the former. The logical difference between the analogical and homological models consists in that the former involves two levels of phenomena while the latter involves only one level. The alleged explanations of psychological phenomena in the various contexts of phsyiological psychology (physiological models), behavioristics (cybernetic models & operant models), and logical positivism (physical models), all represent the variations of homological explanation.

The principle of homological explanation constitutes the basis of the doctrine of reductionism. Accordingly, reductionism may manifest many variations provided its given entities and hypothetical entities always remain at the same phenomenal level. Our discussion will be concerned with the logic of reductionism in general, and we shall refer to the physiological and physical forms of reductionism as special cases. Accordingly, the general problem of reductionism, that is, the logical possibility of the explanation of the phenomena of one science with reference to the phenomena of another science, despite the phenomenological gap between them, may be restated in two ways: (a) Are the phenomena of psychology nothing but the epiphenomena of physiology, and consequently, is psychology reducible to physiology? (b) Is the technical language of psychology translatable to the physicalist language, and consequently, is psychology reducible to physics? In the context of psychology, the corresponding reductive tendencies have been manifested in two antagonistic forms: The one tendency has been along the lines of physiological reductionism (e.g. reflexology), and the other tendency along the lines of physical reductionism (e.g. behaviorism). Thus, for example, while some consider physiology to lie at the root of the phenomena of psychology, others reject the study of physiology as irrelevant and seek their models rather in physics. In both cases, the contents of psychology proper are considered to be ontogically less real than the contents of physiology and physics respectively. In contrast to these tendencies, gestalt psychology and genetic psychology, through the employment of the anological explanation, have opened a way which render reductionism dispensable. They have demonstrated that psychology can have its own inferred entities, and it need not borrow these from physiology or physics; that, in effect, the psychologist can study the genesis and morphology of psychological processes as the botanist studies the same aspect of the plants. These demonstrations have been made in the areas of the perceptual and thought processes. And the same demonstrations have contributed to the renaissance of objective psychology, which promises to be the natural science of not merely psychological phenomena but also of the underlying psychological processes. Let the history of psychology tell the tale of the resulting theoretical strife when it has terminated. We shall, instead, outline the logical critique of the doctrine of reductionism.

Two sciences may be said to be on different phenomenological levels when there is a qualitative difference between their phenomena, and consequently, when the laws of the one science are not sufficient for the explanation of the phenomena of the other. Accordingly, two sciences may be described as "continuous" when they are at the same phenomenological level; and "discontinuous" when they are at different phenonemological levels. Now the logical conditions of the reduction of one science to another permit the reduction of continuous sciences but not that of discontinuous sciences (cf. Nagel (234)). Thus, for example, mathematics may be reduced to logic; but psychology cannot be reduced to physiology. And we may define the *reductive fallacy* as the attempt to identify the correlated phenomena of one science with those of another when the two sciences are located at different phenomenological levels. Thus the color phenomena are *not* identical with their correlated wavelength data; the felt heartbeats are *not* identical with the corresponding cardiographic curves. And Fechner's psychophysical law ($S = K \log R$), that the intensity of the sensation is directly proportional to the logarithm of the intensity of the stimulus, is a classic description of the correlation of two sets of phenomena. In all these cases, to go beyond the given correlation of the two events, to identify them ontologically, would constitute the reductive fallacy par excellence. As Wittgenstein (369: 5.5303) has observed: "Roughly speaking: To say of *two* things that they are identical is nonsense, and to say of *one* thing that it is identical with itself is to say nothing." Of course, here we are concerned with phenomena and not with propositions, and the critique of the "empirical identity" leaves the "logical identity" unaffected: For it is always possible for two different propositions to express the same thought and therefore be logically identical (cf. Frege (97)). In any case, if the old philosophical saying, to the effect that behind every paradox hides a fallacy, be true, then the reductive fallacy provides an explanation for the paradoxical predicament of the doctrine of reductionism. For reductionism begins by assuming the phenomenological duality between the reduced entities and the reducing entities; and, subsequently, it attempts to eliminate the same duality which constituted the necessary startingpoint of the process of reduction. The reductionist then calls the one set of phenomena *less real* than the other set, which is clearly a case of *petitio principii*. With regard to reality, it will be well for the reductionist to remember that epistemologically, psychology constitutes a propaedeutic science, that the objects of other sciences are "known through" the objects of psychology.

The main argument for physiological reductionism is to the effect that when all the physiological bases of psychological processes have been discovered and mapped out, then psychology may be said to have been properly reduced to physiology. (Thus, for example, the sole argument for reductionism given by Bergmann (34) consists of the establishment of a perfect "coordination" between the elements and processes of the two systems). Let us take this argument to the letter of its word. Let it be *assumed* that all the physiological correlates of every psychological process have been discovered and plotted out. Then from this factual evidence only the following conclusion can be logically deduced: That the relationship between the two spectra of phenomena, and consequently between the two sciences, may be described as that of *parallelism*. But parallelism by no means implies reductionism. For we will have established a correlation between the two sets of phenomena, and this correlation does not constitute a ground for their identification. Strictly speaking, on the basis of their correlation alone, the reduction of psychology to physiology will remain as unwarranted as the reduction of physiology to psychology. And if it be argued that the physiological dimension has a causal relationship to the psychological dimension; it may be simply pointed out that the reverse of this relationship also holds true. The science of psychosomatic medicine, which contains two antithetic categories of diseases (somatogenic cases and psychogenic cases), provides us sufficient evidence for the two-way interaction between the physiological and psychological processes. In general psychological factors too, like physiological factors, have the potency to affect the homeostasis of the organic system. It may be concluded, then, that the reduction of one science to another, on the sole ground of their parallelism (coordination) remains without logical foundation. It is a source of gratification for the author to find that the conclusions obtained here, as a result of protracted research, have been obtained elsewhere and from different angles (especially by Köhler (173) and Feigl (89)).

If the reduction of psychology to physiology is logically impossible, despite the complex interaction and profound relationship between the two sciences, the question of the reduction of psychology to physics remains. Neopositivism and behaviorism, which have maintained the thesis of physical reductionism on the basis of a limited principle of verification, suggest that the language of physics is to be regarded as the universal language of science, and that consequently, the science of psychology can and ought to be rendered in the physicalist language. Thus, for example, Carnap (59) has argued for the "physicalist language" (*physikalische Sprache*) to be made the "universal language" (*Universalsprache*) of "empirical science" (*Wissenschaft*), and for psychology to be translated, *without remainder*, into the physical language. For, according to Carnap, the objective (intersubjective) contents of psychology, being operationally verifiable, can be described in the physicalist language; and the intrasubjective contents of psychology, being operationally unverifiable, remain "meaningless", and therefore cannot be expressed in the physicalist language. Accordingly, the concepts of psychology, when meaningful, are reducible to those of physics; and, when not thus reducible, constitute so much meaningless verbiage. We have examined "operationism", the instrument of reductionism, previously (cf. Chapter 8: III). The viewpoint of Carnap is representative of the school of logical positivism in its best form. A critique of this viewpoint has been written by K. Duncker (77), the gestalt psychologist, and it will be stated here. According to Duncker, "verification" is an amphibolic concept and positivists generally use it loosely. For the term "verification" may mean "direct verification" (public verification) or "indirect verification" (subjective verification). The intrasubjective phenomena of psychology, though not directly verifiable (like the intersubjective phenomena), are nevertheless indirectly verifiable. In this respect there exists a valid analogy between the sciences of psychology and medicine. For the subject's description of his psychological experience is not, in principle, different from the physician's description of his patient's disease. And when both the subjective experience and the disease have passed away, the testimonies of the subject and the physician alone remain. There is no more reason to reject the subject's introspective report of his experience than there is reason to discard the physician's case-history of his patient. For, any other physician of comparable competence, in his place, would have diagnosed the same disease. And any other subject in the same context, the organismic factors being constant, would have experienced the same phenomenon. Duncker then concludes, correctly, that the contents of psychology are in principle verifiable without being reduced to those of physics. It may be observed, in support of the gestaltist defence of the autonomy of psychology, that the positivist principle of verification is an inadequate criterion of meaningfulness; and that, consequently, it is to be replaced by the principle of realistic verification which we have described earlier in the present chapter. It may be noted, further, that psychological configurations are logically irreducible to physical systems (cf. Chapter 7: I).

After all the logical evidence against it, let it be supposed that reductionism is both a valid and a possible programme: Let it be supposed that the systematic reduction of psychology to physiology is somehow achieved. What would then be the logical consequence of this reduction? It would appear that, as a result of it, the reductionist might find himself trapped in a vicious circle: Psychology would be reduced to biology (physiology), biology to general chemistry (biochemistry), chemistry to general physics (nuclear physics), physics to mathematics (geometry and topology), mathematics to logic (metamathematical logic), and logic to psychology (Denkpsychologie). To describe this reductive concatenation as the "circle of sciences", and to maintain that it represents the essential "unity of sciences", does not eliminate its vicious nature. For the fundamental question remains: What is the epistemological worth of such a circular reduction which contains its own repudiation within itself? To which the only logical answer is, from the standpoint of phenomenological realism, *nothing*.

We may conclude our logical arguments against reductionism with the words of the genetic epistemologist (Piaget (265: III p. 273)): "*Le premier résultat de notre enquête est que la connaissance scientifique ne saurait être réduite à un schéma unique, mais qu'elle diffère singulièrement d'un genre de disciplines à un autre.*"

In its older form the weapon of reductionism, namely the commonplace "Occam's razor", which has become dull through centuries of logical abuse, is no longer effective in levelling weed and flower alike, as it once did. But its modern successor, the "positivist's bulldozer" (apt nomenclature of Prof. Spiegelberg), still brings down timber in the phenomenological forest. However, these extreme positions have been characteristically representative of philosophical schools rather than of scientific research.

In this respect, it may be noted that the programme of the Soviet School of physiological psychology, which has been commonly criticized as being reductive, is in reality not reductive but rather represents the perspective of scientific epiphenomenalism. And the essential features of this school are to be sought in its later rather than its earlier phase. Thus, I. P. Pavlov (249) himself, though he originally formulated the objective of the school as "identifying the physiological with the psychological" in his "Reply of a Physiologist to Psychologists" (1930), nevertheless subsequently carefully limited the application of physiological reductionism to the animal realm, preserving the investigation of the "inner world" of *homo sapiens* for the special methods of experimental psychology. In the same light is to be understood the work of B. M. Teplov at the Institute of Psychology (Moscow) who writes today: "The basic task of Soviet psychology is to discover the materialist explanation of man's psyche and consciousness" (cf. Simon (320: p. 259)). To investigate the physiological correlates of psychological phenomena by no means implicates the reduction of the latter to the former. Indeed, the phenomenal cosubsistence of the two levels is presupposed in all such epiphenomenological investigations. And, of course, the permanent value of all this research in physiological psychology consists of its deep-rooted naturalism by comparison to which the work of behaviorism in America (especially the concept of the "empty-organism" in the context of operant behaviorism) appears as the highly artificial product of a superficial philosophy of science.

Yet the *Grenzbegriff* of physiological psychology must never be overlooked. For, if the sufficient solution to psychological problems is to be found within the matrix of physiological mechanisms and processes, then the methodology of physiological research will be sufficient for psychology. That this is far from being the case, that the investigation of psychological phenomena require a special set of indirect methods, is attested by the history of experimental psychology. It is this methodological limitation which must be held responsible for the recent criticism of reflexology by some objective psychologists (notably Lashley (190) (193)) and by the ethologists (notably Lorenz (206)). The historical rise of psychology as a science was mainly due to the fact that there existed a class of natural phenomena which fell beyond the scope of the other natural sciences. Thus, from psychophysics to typology and from introspective research to psychogenetic methods, psychology has advanced by the discovery and employment of sophisticated methods adapted to this realm of phenomena. Of course, there is no questioning the great value of physiological research for psychological explanation, but methodic substitution is another matter. Hence the appropriate description of themselves by some members of this class as "a group of psychologists in search of the subject-matter of their science" (cf. Wetter (366)). Yet, even at the level of physiological psychology, the phenomena of "types" have manifested themselves repeatedly: Pavlov (249) himself distinguished the psychological types of dogs on the basis of the patterns of their conditioned reflexes; and Kretschmer (188) has established the functional correlation between constitutional types and personality systems with characteristic pschopathological predispositions. And if differential psychology will be developed within the Soviet School, it will be on the basis of of the researches of Teplov, which have laid the foundations for a differential physiology of the higher nervous system. But, as already indicated, from the fact that physiological factors constitute one category of causal factors in the determination of psychological phenomena, it does not follow that psychology is reducible to physiology without remainder.

If our critique of the hypothesis of physical reductionism be valid, then the relationship between the mind (the Ψ-system) and the body (the Ø-system) must be explained on a different basis than that of reductionism. It will be our contention that the classical mind-body problem, that is, the possibility of the causal interaction between the physiological and psychological processes, must be dealt with phenomenologically. How, for example, are the common phenomena of psychosomatic medicine possible? Scientific observation has recorded a diverse range of such phenomena: For instance, prolonged anxiety generates peptic ulcers in man as well as in the ape (Brady Experiment

(1958)); the majority of degenerative diseases are the result of chronic emotional diatheses (Dunbar (76)); and the physical symptoms of hysteria are the result of the "spilling over" of negative emotions into the organic system (Freud (99)); etc. The classical theories of substantial dualism and physical monism both have failed to provide an adequate solution to the mind-body problem: The former because it found *nothing* in common between the two substances; and the latter because it found *everything* in common between them. For this reason, in recent philosophy, the mind-body problem has been treated no longer as an ontological problem but as an epistemological problem. Accordingly, the problem is reformulated, not in terms of the unity or plurality of *substances*, but rather in terms of the varieties of the *phenomena* to be known. And it is in this context that the hypothesis of *phenomenological parallelism* may be suggested: That is, to every psychological configuration corresponds a physiological structure such that the two are functionally interdependent but phenomenologically located at different levels of reality. Accordingly, it is by means of the concept of "phenomenological spectrum" (to be elucidated in the last chapter of this treatise) that the stratification of natural phenomena is to be determined. And when this has been done, that is, when the *realms* and *levels* of phenomena have been delineated and described, then the phenomenological relationship between mind and body will be explained in functional terms. And since the precondition of functional parallelism is structural isomorphism, the mind-body interaction must be explicated with reference to the concept of *structure*. Modern research in psychology has already revealed that there are various levels of structural groupings: logical, physical, biological, psychological, etc. But, behind the phenomenal variety of groupings, there lies the fundamental unity of their logical forms.

Illustration: The concept of structure constitutes the cognitive medium between the subject and the object. It is on the basis of this concept that we are able to understand the epistemological problem posed by the neurophysiology of Johannes Müller: Namely, how it is possible to explain the qualitative heterogeneity of sensations on the basis of the qualitative homogeneity of the nerve impulses for any given sensorium? The transmission of the neural pattern, from the primary receptor to the sensorium, results in a sensation which reflects a parallel pattern. And this sensorial pattern is preserved, albeit modified, in the perception of the object as a *gestalt* by the subject. Hence it follows that, if the visual and auditory nerve fibers of a cat be interchanged, at the points of cortical termination, it will not simply "see thunder and hear lightning", as Müller has observed, but see it and hear it differently. The explanation, it is suggested, is to be sought in the *patterns* of the nerve currents and not in their *contents*. The resent research in physiological psychology, especially by Buytendijk (53) and Köhler (178) among others, which represent parallel lines of analyses, has thrown much light upon the psychophysical problem.

The history of the hypothesis of psychophysical parallelism is to be traced to the very beginnings of the science of psychology: Thus variations of this explanation were formulated by G. Th. Fechner and H. Høffding among others. In contemporary psychology, the same explanation is maintained, in different forms, in both gestalt psychology and genetic psychology. We have previously had the occasion to discuss the researches of Köhler (176) (177) which have reformulated the hypothesis of "psychophysical isomorphism". Similarly, Piaget (263), in a technical essay on the neurological aspects of the operations of thought, has elucidated the thesis that psychological phenomena and physiological processes represent the *same pattern* in *different media*. Consequently, Piaget (265: III) has summarily concluded that the relationship between the two classes of phenomena must be described with reference to their "irreducibility" and "parallelism". Corroboration to these explanatory conceptions of the gestalt and genetic theories is to be found in the experimental results of objective psychology: Thus, the "coalescence of neurology and psychology", of which Lashley (191) speaks, implicates the hypothesis of parallelism; and the physiological "record of consciousness", verified and reported by Penfield (250), presupposes the conception of psychophysical parallelism. It is noteworthy that research in the philosophy of the physical sciences even has arrived independently at a similar conclusion: "The recognition that physical knowledge is structural knowledge abolishes all dualism of consciousness and matter. Dualism depends on the belief that we find in the external world something of a nature incommensurable with what we find in consciousness; but all that physical science reveals to us in the external world is group-structure, and group-structure is also to be found in consciousness" (cf. Eddington (80: p. 150) and also Margenau (219)).

The discovery of *physical gestalten*, analogous to the *psychological gestalten*, remains the permanent contribution of Köhler (174) to the philosophy of science. And, in the light of this discovery, it has become apparent that, not merely are psychological configurations not identical with the additive aggregate of their physical components, but even in the realm of physical systems the properties of organized entities cannot be adequately described in terms of their constituent elements alone. Consequently, at the physical level as well as the biological level, the class of "functional wholes" is to be distinguished from the class of "summative wholes". The former, unlike the latter, are not susceptible to analysis from the "additive point of view" because of their integrative *Gestaltqualitäten.* Of the whole class of "physical gestalten", which Köhler has examined in great detail, we may consider the illustration provided by electric field effects. Thus, for example, a typical electric conductor maintains a specific density of electric charge, which is not evenly distributed at all points of its surface, even though its electric potential remains uniform throughout its surface. As a rule, the density of the charge will be greatest at the points of the greatest curvature and weakest at the points of the least curvature of the conductor. This special case of the surface distribution of the electric charge, being independent of the intensity of the total charge, is a function of the physical configuration of the conductor itself. There is an analogous phenomenon in chemistry (which might well be called a "chemical gestalt"): This is the phenomenon of isomerism, where, the elementary contents of the compound being constant, the variation of the chemical structure of the compound results in the modification of its physical properties. It is evident, then, that there exists a level of physical reality in which physical systems represent physical gestalten, chemical compounds chemical gestalten, whatever else they may represent besides. Hence Köhler (174: p. 158), in criticizing the philosophy of atomism, is justified in his concluding observation: "The *important* point is missed: viz. the existence of self-enclosed, finitely extended Gestalten with their scientifically determinable natural laws [*Eigengesetze*]. *In the physical world,* as has been shown in the foregoing pages, *it is precisely segregated physical systems to which the laws of nature apply.*" The "segregation" of physical systems, however, does not mean total discreteness, given the permanent context of the field effects, but rather the intrinsic integration of the objects as a configuration.

On the basis of the observations in the foregoing pages, we may state our general conclusion: That the existence of configurational wholes, the elementary components of which are functionally integrated, may be accepted as an established fact in the realms of biology and psychology. Contemporary philosophy of science has at last come to realize this important dimension of objects (cf. Nagel (234)). But this realization necessarily constitutes the first step toward a realistic philosophy of natural sciences which must proceed, logically, from the concepts of configurational grouping and natural types to the conceptions of structural order and phenomenological levels. This line of thought has been already illuminated by the ontological studies of Hartmann (125) and the cosmological studies of Whitehead (365). We have sought to follow, in this treatise, a parallel line of analysis within the limited context of our subject. Therefore, we have regarded the relationship between the families of the biological and the physical sciences from the standpoint of structural affinities rather than reductionism. Indeed, the philosophy of science can afford to neglect this structural aspect of natural phenomena only at the high price of a profoundly significant portion of reality itself.

Concluding Note

The epistemological perspective which we have endeavoured to sketch, within the general framework of phenomenological realism, has been derived from two main sources: The empirical discoveries of genetic and gestalt psychologies; and the recent philosophical trends (representing variations of realism) which corroborate that scientific evidence. The essential concepts employed in this sketch are those of *structure* and *level*: The former has been analyzed previously (cf. Chapter 7), and the latter will be subjected to analysis later (cf. Chapter 10). It is evident that these epistemological concepts have potent consequences for the philosophy of science in general. In the remaining chapter, then, these implications will be integrated and elucidated in the form of a prolegomenon to a realistic philosophy of natural sciences (especially biology and psychology).

CHAPTER 10

PROLEGOMENON TO A REALISTIC PHILOSOPHY OF SCIENCE

The theoretical path from natural science to the philosophy of science proceeds along the outlines of the *logic of* science. But the "philosophy of science" is something more than the "logic of science." We have attempted to explicate some aspects of the logical structure of science, especially with reference to its methodological and epistemological rationale, in the two preceding chapters. And in that context it was noted that our theoretical analyses contained certain logical consequences for the philosophy of science in general. Generally speaking, two things point toward a reconstruction in the philosophy of science: One of these factors consists of the interpretation of the phenomena of gestalt psychology and genetic psychology (as well as functional psychology); and the other factor consists of the synthetic integration of the ramifications of the epistomological conceptions which we have discerned at the foundation of empirical psychology. The objective of this last chapter, then, will be to sketch the prolegomenon to a reconstruction in the philosophy of science from the standpoint of phenomenological realism.

It will be seen that the realistic philosophy of science provides an objective and transcendent perspective relative to the physicalist viewpoint of logical positivism and the subjective viewpoint of contemporary existentialism. It has been already observed that both of these antithetic viewpoints prove to be inadequate as philosophies of science: For, generally, the former adopts a negative attitude toward the "subjective phenomena" of psychology, and the latter adopts a negative attitude toward the "objective phenomena" of psychology. And, in the last analysis, it is this epistemological one-sidedness of these current viewpoints which is responsible for whatever specific methodological limitations they appear to be guilty of. The perspective of the realistic epistemology, which we have attempted to unravel, at least in its rudimentary form, strives toward the achievement of a critical synthesis between the subjective and the objective. In contemporary European thought the way to such a critical synthesis has been prepared, in the form of a "third alternative" constituting a new "scientific ideal" in the area of the biological and psychological sciences, by the Phenomenological Movement, with which the realistic outline presented here bears a partial affinity. Our reflections concerning the philosophy of science may be regarded to be of the nature of a programmatic essay rather than that of an exhaustive treatment. And our usage of the term "philosophy of science" is to be understood primarily in a strict sense (referring to the psychological and biological sciences) and only secondarily in a general sense (philosophy of natural sciences in general).

We shall begin with an examination of the logical qualifications of psychology as a natural science; for it is the philosophy of natural sciences that we are concerned with here. From the science of psychology (specifically cognitive psychology) to the "psychology of science" is but a direct epistemological path. Consequently, it is to be expected that both gestalt psychology and genetic psychology would have taken some steps along that path. The result has been, in the former case, the inauguration of a "gestalt epistemology," and in the latter case, of a "genetic epistemology." We shall review these varieties of epistemology within the framework of the "psychology of science." Lastly, we shall outline the underlying structure of the complementary philosophy of science.

I. PSYCHOLOGY AS A NATURAL SCIENCE

The conception of psychology as a natural science, which has constituted our underlying assumption throughout this work, is, of course, an old conception with a long history. However, it would be highly germane, in the present context, to explicate its rationale. For, if we are to explore the nature of the philosophy of science, mainly on the basis of the science of psychology, then we must first have demonstrated that psychology itself is a natural science. Modern psychology, generated from the common parentage of physiology and philosophy, was conceived to be a "natural science" by its two founders, W. Wundt (372) and Wm. James (146), who contributed to the formation of psychology as an "experimental science" and a "theoretical science" respectively. Since then this basic conception has constituted a common denominator between the various schools of psychology—between gestaltism and geneticism, ethology and psychoanalysis, as well as functionalism and behaviorism. However, since the history of an idea is not identical with the logic of that idea, and since historical authenticity does not constitute logical validity, we shall say nothing more about the former and return to the latter aspect of the matter.

There appears to be a prevalent misconception concerning the nature of psychology, especially amongst its outsiders, to the effect that psychology must vaguely belong to the class of the "social sciences." Whatever the semantic significance of, and the methodological ground (or rather the absence thereof) for, the term "social sciences," we shall refrain from examining the matter here. Instead, the sources of this misconception may be pointed out: There is, firstly, the popular notion that psychology studies man as a "social animal," and that consequently, its general approach must somehow be similar to that of the "social sciences." And, secondly, there is the common impression that, instead of there being one objective psychology, there are many "psychologies," divergent and incompatible, and that consequently the state of affairs in psychology seems to be characterized by the same kind of "confusion" which appears to be a chronic trait of the "social sciences." The fact that, among the various aspects of human nature, the "social aspect" is to be included, and the fact that a certain amount of theoretical conflict is the perennial lot of all the natural sciences, including psychology, cannot be gainsaid. However, behind these apparent facts lies the fundamental logical affinity between psychology and the other natural sciences, an affinity grounded in their methodological isomorphism (which is not shared by the primitive methodology of the "social sciences"), and the explication of this affinity shall constitute our logical defence of the conception of psychology as a natural science.

The logical affinity between psychology and other natural sciences (especially biological sciences) rests upon two general frameworks inherent in the very nature of psychological science. The first framework consists of the methodological schema common to the biological and psychological sciences. The second framework consists of the theoretical schema underlying the various schools of psychology despite their divergent viewpoints. We shall analyze the nature of these general schemata in the following.

The methodological framework of the biological and psychological sciences may be summarily outlined as follows:

(1) The systematic formulation of a set of general methods and special techniques within the fourfold coordinates of qualitative, quantitative, longitudinal, and transverse dimensions.

(2) The experimental observation of the given phenomena, in con-

trolled contexts, and the exact description of these phenomena in a standard terminology.

(3) The classification of the phenomena into various categories on the basis of their "family traits"; and the discovery of "natural types" corresponding to this classification.

(4) The determination of "functional laws" (qualitative laws and quantitative laws) which regulate the relationships between the natural types and their variations.

(5) The construction of theories for the integration of the "natural types" and their "functional laws," by means of higher level conceptions, into a general system. Prognosis and practical applications, which are the biproducts of the theoretical system, have only a secondary theoretical importance in the context of natural science.

The problems of experimental method (qualitative and quantitative) together with the problems of theory construction have been discussed in greater detail previously (cf. Chapter 8). Here we shall confine our discourse to the problem of the "natural types" and their role in the natural sciences.

Psychology may be described as the natural science of the cognitive, emotive, and adaptive phenomena of the higher organisms. The determination of the natural types of phenomena, and of their natural laws, remains the permanent objective of psychology. It is true that, as the historians of psychology have observed, psychology, as a natural science, has "a long past but a short history." In the preface of one of his books, Piaget (261) has noted that, while botanists have catalogued all the herbs of the earth, and zoologists have taken assessment of the filaments of the pettiest of animals, the science of psychology, which studies the ontogeny and morphology of the thinking of the *homo sapiens*, still remains at an elementary stage. However, whatever the degree of progress manifested in the history of psychology, the naturalistic objective of psychology has remained constant. It is this objective that essentially distinguishes genuine *science* from mere *statistics*. It is also the same objective, together with its experimental and theoretical methods, that separates the natural sciences from the "social sciences." A peculiar interrogative exclamation sporadically recurs in the every day context of academic scene: "What is wrong with the social sciences?" Perhaps the plight of the so-called "social sciences" (which should properly be called "social studies") might be explained with reference to their inveterate misconception of the nature of scientific research. In the context of natural sciences, "research" refers to a systematic experimental and theoretical study of a given phenomenon by means of standardized methods; but in the context of "social sciences," "research" has become the equivalent of random data-collection. And the tendency to give the "social sciences" the name of "behavioral sciences" represents an ineffective effort to save this pedestrian version of "research"; but it must be remembered that we do not cure a disease by giving it a new name. An aged naturalist, under whom this author had the privilege of studying a long time ago, always made the point, concerning the distinction between science and statistics, by the use of an hypothetical paradigm: Let a systematic botanist, who knows but a part of all the plants of the earth, and a statistician, who knows all the plants of the earth, be placed upon a distant planet full of strange plants none of which are identical with those of the earth; it is certain that the systematic botanist, on the basis of his analysis of the morphology of the planetary plants and the estimation of their family affinities with the terrestrial plants, shall be able to tell something about the probable qualities of those strange plants to the bewildered statistician, were not the latter, as the victim of the superficial resemblance of planetberries to earthberries, poisoned to death already. That this naturalist also happened to be a platonist is beside the point, for the lesson of modern biological morphology remains essentially the same. What Charles Darwin wrote concerning the objectives of biological sciences in the *Origin of Species* (1859) remains essentially true today: "...The members of the same class, independently of their habits of life, resemble each other in the general plan of their organisation. This resemblance is often expressed by the term 'unity of type'; or by saying that the several parts and organs in the different species of the class are homologous. The whole subject is included under the general term of Morphology. This is one of the most interesting departments of natural history, and may almost be said to be its very soul.... Embryology will often reveal to us the structure, in some degree obscured, of the prototype of each great class." The conception of "morphology," which may be traced to the botanical researches of Aristotle and Goethe, formed the common bond between the divergent schools of Buffon and Lamarck, of Baer and Cuvier, and of Darwin and Agassiz. Indeed the history of the biological sciences may be described as the systematic search after the natural types and the laws of their evolution.

In the context of psychology, the search after the natural types has taken various forms. The research concerning the "primary colors" (psychology of perception), the "types of thought processes" and the "types of learning" (cognitive psychology), and the "primary traits" (differential psychology), to name the main trends, constitute variations of the same general methodological objective. The concept of type plays a specially fundamental role in the area of comparative psychology: The experimental and theoretical researches of R. M. Yerkes, W. H. Sheldon, E. Kretschmer, and E. Spranger represent outstanding contributions in morphology. The logical rationale for the interest that psychology takes in the study of types may be explained with reference to the nature of its subject-matter: Psychological phenomena, as natural phenomena, are generally the manifestations of natural types; consequently, psychological research must be coextensive with both the phenotype and the genotype. Indeed, it is on the basis of the knowledge of the types, that we can properly speak of the "typical case" of a given class of phenomena, or of the "characteristic trait" of an organism, or that we can legitimately use the term "essentially." For the essence of a given object consists of its type; and its characteristic property is the product of its typical trait. The necessity of the concept of type has been described in the classic work of Kretschmer (188: pp. 395–99): "Is it at all *necessary* to establish types? Does one methodologically need the concept of type (*Typenbegriff*) in modern constitutional biology? It is to be said first of all: When we have established, through careful empirical research, that a series of important correlations converge at a definite point of our materials, so we must at least give this point a designation... Now call this Type, or Correlation-formula, or whatever you please; we intend to leave such idle disputes over nomenclature to theorizers... The concept of type is for us an irreplaceable thought-model for the treatment and arrangement of the empirical facts of the cases. And the exact natural sciences have properly constructed such a productive heuristic thought-model in their epistemological framework." While Kretschmer speaks from the point of view of the naturalist, it is possible to demonstrate the necessity of the concept of "type" in the natural sciences from a logical standpoint. In this respect we may refer to the work of A. N. Whitehead (365) where the logical case for the structural "order" of natural phenomena is outlined. All phenomena appear to have some degree of structural order, and this order ranges between the "generic ideal" and the "complete disorder," according to the principle of the maxima and the minima. The concept of the "generic ideal," representing the perfection of natural order for a given species of being, corresponds to the concept of the "type" in the natural sciences. And, as Whitehead (365: p. 128) has contemplated the history of science, natural sciences cannot do without this concept: "It is noteworthy that no biological science has been able to express itself apart from phraseology which is meaningless unless it refers to ideals proper to the organism in question." From a logical point of view, the comparative descriptions of the particular cases in the biological sciences presuppose the establishment of the natural types as the exemplars of comparison.

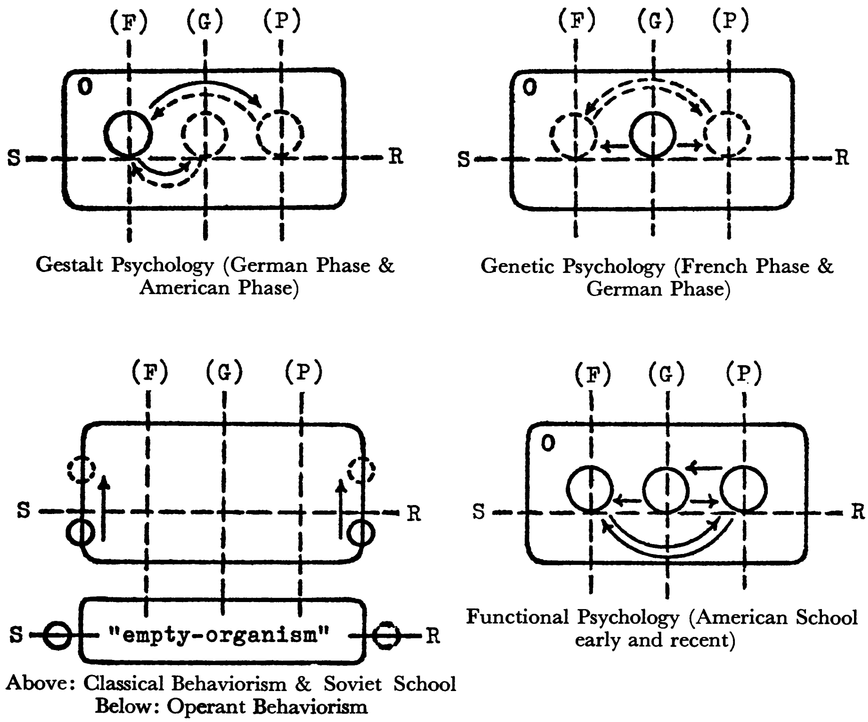
Granting the importance of the concept of type in the natural sciences, the epistemological problem concerning our knowledge of the types remains. What are natural types and how do we know them? The determination of the *type* is a different process from the simple *classification*. A set of objects may be classified together on the basis of practically any given common property. But the determination of the natural type necessitates the comparative study of all the properties of the object and their analysis into *essential traits* and *peripheral traits*. As Kretschmer (188: p. ix) has observed: "The essential thing for a type is, not how many cases belong to it, but what it discloses." Epistemologically, the type corresponds to the concept, and the particular case to the percept. And the integrative principles of typological synthesis, called the "principle of intensification" (*Verstärkerprinzip*) by Kretschmer (188), corresponds to the principle of conceptual abstraction. Accordingly, the conceptual boundaries of the types themselves are sharply defined; but the perceptual boundaries of the cases representing the types are gradually differentiated. Let us take an example from experimental psychology: In the psychological spectrum the chromatic colors are arranged around the color circle in the order of their similarities. An inspection of this color spectrum indicates that the range of phenomena involve vertices and peripheries. The peripheral phenomena (mixed colors) cluster about the vertices (pure colors: blue, green, red, yellow). The peripheral shades of color belong together in distinct groupings according to their relative resemblance. We may call then the vertices of color phenomena the "types," and their phenomenal periphery the particular "cases." It was indeed in precisely this way that the psychological theories of colors were formulated (e.g. Hering's theory). Ontologically, the types may be conceived of being "archetypes," and their particular cases "ectypes," the latter being determined by the former. In any case, the natural types themselves, after being determined, may be subjected to further phenomenological study: This study generally involves an analysis of the intensional structure of the types and of the functional relationships between the types. This analysis, in turn, will lead to the problems of ontogeny and function connected with the natural types. It will be noted here that our analysis of the concept of "type" and of "typology," in the context of psychology and biology, is corroborated by the theoretical studies of Strunz (331) and Winthrop (368).

As a natural science, psychology assumes, as a necessary condition for its experimental researches, a theoretical framework. This theoretical framework consists of three basic and interrelated dimensions: (1) *morphology* or the form and transformation of psychological phenomena, (2) *function* or psychological processes and their interrelationships, and (3) *ontogeny* or the genetic evolution of psychological phenomena. The counterpart of these theoretical dimensions may be seen in the biological sciences in general. In biology proper, for example, it is possible to logically classify all observations under three essential categories of: comparative anatomy and botanical morphology, physiology and pathology, genetics and embryology. Similarly, the science of medicine represents a parallel triad of dimensions in the descriptions of a given disease: For the medical "case history" consists of the description of the origin and progress, form and symtomatology, and result and after-effects of the pathological phenomenon. With respect to the interrelationship of these theoretical dimensions, it may be noted that they are to be considered as being, not merely complementary, but also necessary to each other. For the complete knowledge of a natural phenomenon requires the threefold analysis of its form, function, and history, and the integration thereof. As Dr. Alfred Romer, the comparative anatomist, has observed, embryological analysis is indispensable for the verification of homologies in comparative biology. We shall refrain from a detailed discussion of the ramifications of these essential aspects of the biological sciences—with which the students of psychology are expected to be properly familiar—and briefly assert the conclusion of our general observations: From the standpoint of the objectives of natural science, there exists an implicit theoretical parallelism between the frameworks of the psychological and the biological sciences.

The three-dimensional theoretical framework of psychology, which we have outlined, may be inspected either externally or internally. Externally viewed, it constitutes the logical affinity between psychology and biology. Internally viewed, however, it provides the foundation for the general unity of the psychological science itself. For, in the light of this framework, we no longer discern "many psychologies" but a single multidimensional natural science. Considered in this light, the various "schools of psychology" appear to be, not so many independent disciplines, but rather different perspectives with variations of experimental and theoretical focus and content. And if we refer to the vantage point of a given school from a given theoretical dimension as the "perspective" of that school, then these perspectives may be described as being complementary. It is possible to construct a schema representing the complementarity, overlapping, and conflict of psychological systems: Thus the theoretical perspectives of modern systems of academic psychology, with which this work is concerned, have been represented schematically. The method of our diagrams is similar to those constructed by E. Brunswik (49), but the contents of the two have nothing in common, since the main theoretical dimensions involved are different in the two sets of diagrams. It will be seen that the perspective of gestalt psychology originates in the dimension of morphology and thence proceeds to those of function and ontogeny: Here form appears as the explicit determinant of function, function an implicit determinant of form, and there is a bilateral relationship between form and history. The perspective of genetic psychology, in contrast, is grounded in the genetic history of the organism: Here ontogeny appears to be the explicit determinant of both form and function, while there holds a bilateral relationship between the latter dimensions. And the meaning of the common aphorism in genetic psychology, to the effect that "in the beginning was the response," is to be interpreted in this special context. The theoretical frameworks of the German Phase and the French Phase of genetic psychology are to be distinguished mainly by their interpretations of the form-function relationship: In the former case the relative emphasis is upon form, and in the latter case it is upon function. That this basic theoretical difference should exist between the two phases is consistent with the historical fact that they were influenced by gestalt psychology and functional psychology in relative degrees. The general perspective of functional psychology, originating in the dimension of function (psychological processes and behavioral adaptation), is gradually extended to the other two dimensions. Accordingly, the principles of the correlativity of form and function, of ontogenetic determinism (as well as the corresponding physiological determinism), and of phylogenetic comparison are integrated in the theoretical framework of functionalism. The fundamental difference between these schools of psychology and behaviorism consists in that the latter substitutes the study of the overt behavior to that of the essential psychological dimensions: Hence the curtailment of the basic S-O-R formula, maintained in the context of the other schools, to the S-R formula, maintained in the context of behaviorism. Within behaviorism, there is the divergence between the classical viewpoint (as well as the corresponding Soviet School) and the operant viewpoint, based upon the fact that, the former seeks the explanation of the S-R correlations exclusively in the underlying physiological mechanisms and processes, and the latter renounces all attempt at explanation by entertaining the concept of the "empty-organism." It is noteworthy, in this regard, that operant behaviorism, by its rejection of the covert psychological dimensions, becomes self-limiting and remains the only school without the advantage of theoretical reinforcement from other schools. In a profound sense, the perspective of psychoanalysis represents the antithesis of that of operant behaviorism. For psychoanalysis is primarily concerned with the symbolic meaning of behavior, rather than the fact of behavior itself, and traces this meaning to a special set of psychic vectors. And even though both behaviorism and psychoanalysis are deterministic, determinism acquires different forms in the contexts of the two schools: It is a case of "external determinism" in the former, and a case of "internal determinism" in the latter. Similarly, while the historicism of psychoanalysis bears a superficial resemblance to that of genetic psychology, it is essentially confined to the emotive realm to the exclusion of the cognitive realm. It would be possible to elaborate further the ramifications of this comparative analysis of psychological schools. However, it is expected that the point has been made sufficiently clear for our present general purpose.

The conclusion of our analysis must needs be stated in a limited form: The general unity of psychological science, based upon a basic theoretical framework (consisting of the psychological dimensions), derives from the relative complementarity of its schools. And even if some schools (e.g. operant behaviorism) may fall outside this framework, since they neglect it, at least they preserve the framework as "empty" without filling it with foreign matter. Of course, specific hypothetical conflicts, especially in the overlapping areas, exist and shall continue to exist. And, in that respect, the state of affairs in psychology is not essentially different from the state of affairs in biology. And if one were to assess the symptomatology of psychology as a natural science, one would observe two things in particular: The first being that the hypothetical conflicts of this science are generally traceable to methodological discrepancies and divergencies; and the second being that the history of psychology, like that of biology, represents a steady advancement by the precipitation of an objective core of knowledge.

Both of these traits contribute to the special character of natural sciences in general. However, from the fact that psychology is a natural science, it does not follow that it is a physical science. Similarly, despite the close relationship between psychology and biology, their essential difference remains: The phenomena of the former, unlike those of the latter, are only indirectly observable. Such essential differences between the natural sciences may be explained with reference to the fact that, while they employ similar methodological canons, they investigate different levels of natural phenomena respectively. And since these various levels of phenomena represent the various aspects of reality in general, the data of the sciences are, not merely ontologically complementary, but also correlated and mutually illuminating. The history of science furnishes us with abundant cases of epistemological correlativity: To cite one example, the discovery of the wave-length of colors in optical physics, the discovery of retinal receptors in physiology, as well as the discovery of primary colors in experimental psychology, all have contributed to our conceptual comprehension of the phenomena of colors. In this case, then, the epistemological correlativity of three natural sciences (physics, physiology, psychology) has furnished us with a general, three-dimensional, knowledge of a single class of phenomena. As Köhler (176: p. 37) has observed: "Not merely is psychology now old enough to stand on her own feet; she is, in my estimation, so developed even that she can occasionally afford to help her older sisters, the [other] natural sciences." These interscience relationships are to be interpreted, not as unilateral and reductive, but rather as bilateral and parallel. And, considered in this light, the sciences may affect each other, not merely with respect to their contents, but also with respect to their methodology as well. However, there are logical limits to the cohabitation of the natural sciences: The uncritical adoption of the methodology of one science by another will be at the price of the phenomenology of the latter. This point has been demonstrated in special contexts by various thinkers: We may only note the work of Zellinger (375) who has analyzed the case of the "irrationalist psychology" with reference to an uncritical assumption of the principles of quantum physics. In general the interscience relationships approach a theoretical limit described by the divergences of their phenomenological contents respectively. It is the task of the philosophy of science, in a profound sense, to describe the theoretical limits of the natural sciences. The relationship of the philosophy of science to the natural sciences is logically uniform; it has no closer ties with one science than with another. Yet some contemporary writers have failed to keep science and philosophy of science logically separate: For example, Bergmann (34) writes that "theoretical psychology is a branch of philosophy of science." Obviously, if theoretical biology and theoretical physics are not branches of the philosophy of science, then theoretical psychology is not either; for if the latter were, the former would have to be. Wittgenstein (369) was far closer to truth in making the observation to the effect that psychology, as a natural science, was no closer to philosophy than was any other natural science. And if it is true that psychology descended from the common parentage of philosophy and physiology, it is also true that the other natural sciences were once branches of the



Gestalt Psychology (German Phase & American Phase)

Genetic Psychology (French Phase & German Phase)

Above: Classical Behaviorism & Soviet School
Below: Operant Behaviorism

Functional Psychology (American School early and recent)

Note: The factors (F), (G), and (P) represent the three constant psychological dimensions of Form (structure), Genetic History, and Process (function), respectively.
— = explanatory concepts
... = descriptive concepts
→ = implicit unilateral relationship
S = stimuli (proximal & distal)
R = responses (reflexive & reflective)
O = organismic variables

Theoretical framework of psychological systems.

tree of natural philosophy. The great affinity that exists between psychology and philosophy is based, not upon the methodological peculiarity of psychology as a natural science, but upon the fact that the subject-matter of psychology retains a greater philosophical significance for man. Thus it appears perfectly consistent for psychology to remain a natural science and yet maintain a special relationship to philosophy in general.

II. PSYCHOLOGY OF SCIENCE: "GESTALT EPISTEMOLOGY" AND "GENETIC EPISTEMOLOGY"

Scientific thought is characterized by a bimorphic nature which enables it to contemplate simultaneously, as its objects, the phenomena of natural universe as well as the nature of science itself. The corresponding double function of scientific thought may be described as the *objective function* (when the object of scientific thought is nature) and the *reflective function* (when the object of scientific thought is natural science itself). When psychology performs the objective function, it is a natural science; when it performs the reflective function, it becomes "psychological epistemology." We have already discussed the former function of psychology in the preceding pages; here we shall examine its latter function.

The natural sciences may be studied from three general standpoints: (1) The *history of science*, which comprises the history of scientific ideas as well as of technological operations. (2) The *psychology of science* (psychological epistemology), which comprises three complementary aspects: (a) The psychological nature of scientific thinking, that is, the structure and processes of conceptual and hypothetical thinking (The researches of gestalt psychology constitute the representative example). (b) The psychological evolution of scientific conceptions and ideas as a function of chronological age as well as historical age (The researches of genetic psychology constitute the representative example). (c) The psychological study of the case-histories of the personality of scientific thinkers as well as of their discoveries (The researches of functional psychology constitute the representative example: Note the biographical studies by C. Murchison and Anne Roe as well as the studies in depth by Hadamard (119)). (3) The *philosophy of science*, which comprises the philosophical foundations of the natural sciences (Since we shall examine this topic later we shall say nothing here). It may be observed that the history of science, the psychology of science, and the philosophy of science perform complementary reflective functions, and that consequently, the three perspectives are indispensable for a complete comprehension of natural science.

The psychology of science is to be distinguished from the philosophy of science in that the former is related to the psychological ground (context of discovery) and the latter is related to the logical ground (context of justification) of science. It follows that *psychological epistemology* is to be distinguished from *philosophical epistemology*: The former is concerned with the longitudinal study of scientific conceptions (longitudinal semantics) and the longitudinal study of scientific hypotheses (longitudinal syntactics); in contrast the latter is concerned with "transverse syntactics" from a purely logical point of view. The psychology of science consists, then, of the psychological study of scientific thought in a systematic way. The result of this study is a psychological interpretation of scientific knowledge, that is, psychological epistemology. And given the various theoretical perspectives within psychology, corresponding variations in psychological epistemology may be discerned. In the following pages we shall examine, comparatively, the two variations in psychological epistemology which correspond to the two psychological schools we have been concerned with: "gestalt epistemology" and "genetic epistemology."

Gestalt Epistemology

"Gestalt theory was the outcome of concrete investigation in psychology, logic, and epistemology," thus concluded Wertheimar, in his historic address concerning *Gestalttheorie* delivered before the Kant Society (Berlin) four decades ago (1924); and the same conclusion essentially characterizes *Gestaltpsychologie* today. There is an epistemological trend, running through the writings of gestalt psychologists, which bears a fundamental affinity with the more general trend of phenomenological epistemology, and which may be properly called "gestalt epistemology." The relationship between the gestalt epistemology and the phenomenological epistemology must be made clear: The former, assuming a longitudinal perspective, is related to the latter as a reinforcing viewpoint; and the latter, assuming a transverse perspective, is related to the former as an encompassing viewpoint. Consequently, the phenomenological epistemology, sketched in the preceding chapter, derives much of its empirical evidence from gestalt psychology, but logically extends beyond the limits of gestalt epistemology. It is important to note the boundary between gestalt psychology and gestalt epistemology: The former is confined to the experimental study of perceptual and cognitive processes, and the latter is concerned with the speculative analysis of the same processes from the gestaltist standpoint. There are some critics of the gestalt school who, having confused the boundary between the two, have blunderingly blamed the one for the alleged defects of the other.

The speculative problems of gestalt epistemology have arisen out of the empirical observations of gestalt psychology. If modern behaviorism does not concern itself with such problems, it is because, remaining complacent with its doctrine of operationism, it has evaded speculative problems rather than solved them. But reflective psychology, that is, the psychology of science performing a reflective function, cannot remain inert in the face of the various epistemological problems generated by natural science (including experimental psychology). Accordingly, the problem of the nature of cognition (our knowledge of the external world), of the phenomenal object and object constancy, of the intersubjectivity of experience, and of the nature of verification and truth, acquire special significance in the context of gestalt epistemology. The hypothetical solutions of these basic problems, to be sought in the context of psychological epistemology, will provide psychological science with a rational framework to take the place of dogmatic assumptions. We shall briefly review the theoretical status of the speculative analysis of these problems by gestalt epistemology.

The "revolution in perception," brought about by gestalt psychology, leaves us with the problem of the epistemological interpretation of perception. There is the "nativist viewpoint," which suggests that perceptual phenomena are determined by a set of inherited traits in the organism; and there is the "empiristic viewpoint," which suggests that perceptual phenomena are the products of learning by the organism. ("Empiristic viewpoint" is to be distinguished from the general empiricism of which it is a special case.) Gestalt epistemology rejects the "empiristic viewpoint," on the grounds that several categories of perceptual phenomena constitute counter-evidence relative to its limited scope of explanation (e.g. phenomena of the appearance and disappearance of perceptual illusions). Neither does gestalt epistemology adhere to the "nativist viewpoint," if nativism be interpreted to imply the impossibility of perceptual variations. The objective of gestalt epistemology, generally stated, consists of the theoretical integration of the facts of evolutionary inheritance and evolutionary emergence, more precisely, of physiological statics and physiological dynamics together with their psychological correlates. Consequently, neither the "chromosomic equipment" of man nor his "conditioning mechanisms" may be regarded to constitute the sufficient condition of the phenomena of perception: There is a third factor, consisting of the formal and functional integration of the organic system regulated by its own qualitative laws, and this constitutes the critical element. W. Köhler (175) has shown that the etiology of thought processes is also to be interpreted in the same way. The general concept of biological and psychological organization is closely related to the concept of "field" and its dynamics, as it has been investigated by W. Köhler (171), K. Lewin (198), and M. Henle (132). Such an interpretation of the genesis of cognitive processes, which anticipates the idea of phenomenological levels, has far-reaching implications: "In some cases, they may affect our very concept of man, and may thus have repercussions even in philosophy" (Köhler (175: p. 295)).

The problems of the nature of *cognition*, then, acquires a fresh interpretation in the context of gestalt epistemology. The problem becomes, no longer that of our knowledge of the external world as a prestructured universe, nor that of the subjective contents of our consciousness *per se*, but that of the forms of phenomenal objects and their objective constancies. Comparing the gestalt epistemology with the classical epistemological theories, it appears that, avoiding the representative theory of Locke and the subjective impressionism of Hume, it is more closely associated with the phenomenalism of William James than with the transcendentalism of Kant. In the course of the William James Lectures, which Köhler (170) delivered at Harvard University, he attempted to separate the "phenomenal object" from the "transphenomenal object", that is, the perceptual gestalt from the objective gestalt. This ontological dichotomy, it may be observed, is based upon similar grounds which the Jamesian dualism of "phenomenal experience" and "pure experience" rested upon: Namely the general phenomenon of the constancy of phenomenal objects. However, while in the Jamesian epistemology the fundamental concept was that of *process*, in the gestalt epistemology the basic concept is that of *structure*.

Since the functions of perception and thinking are essentially structuring processes, their products being psychological configurations, two kinds of configurations are to be distinguished corresponding to these two processes: perceptual configurations and conceptual configurations. The general process of cognition, then, may be described as the comprehension of the structure of phenomena and the patterns of events respectively. The nature of this "structural comprehension" has been variously described, as "participation" (Duncker (79)), as "Verstehen" (Abel (1)), and as "insight" (Köhler (173)). In any case, so far as cognition is concerned, whatever falls outside the realm of structure, is to be "bracketed" as being nonphenomenal. The same principle, it appears, holds true in the case of spontaneous imagination which is essentially the eidetic echo of cognition proper. Conversely, the memory of past perceptions, in the form of associated images, contributes to the cognitive "meaning" of present perceptions. This "contribution of memory", originating in remote perceptions and terminating in proximate perceptions, has been aptly described by Wallach (350: p. 165): "A process of recall by simialrity by which the present perceptual process makes contact with the trace of a similar process of the past, and secondly, recall of a content associated with this trace." What is the exact nature of this associative process, and in what respect is its explication different from that of classical psychology? It has been demonstrated by Köhler (172) that the classical concept of "association", itself remaining unexplained, explained little, and that the associative process is to be understood in the light of functional configurations (e.g. consider the phenomenon of synesthesia as an extreme case). Accordingly, the experimental studies of the perceptual preconditions of association, by Asch (22) and by Bergius (33), have demonstrated that the coherence between the terms of the associative materials is determined by the interrelationship of the units of the same. Generally speaking, the limits of cognition coincide with the contour of the structural manifestation of the object. Accordingly, the gestalt theory has never really abandoned the "constancy hypothesis": For, while it has recognized the cumulative nature of the conscious process and the impossibility of the recurrence of the same states of consciousness, it has steadfastly maintained the constancy of the configurations of consciousness as an explanatory principle of cognition. Thus, to have acquired a knowledge of the external world, the objects of that world must have had the potentiality for structural representation. Toward the establishment of a general cosmology, the researches of gestalt epistemology have revealed four basic classes of configurations: (1) *psychological gestalten* which comprise the configurations of perception and of conceptual thinking; (2) *biological gestalten* which comprise systems resulting from organic integration, regulated by biological laws, and characterized by their partial autonomy from physical laws: (3) *physical gestalten* which constitute a special class of physical systems with integrative properties (cf. Köhler (174)); (4) *logical gestalten* which consist of the configurations of conceptual thought in their final form, that is, in a state of complete equilibrium and capable of progressive transformation and compensation. (This category of "logical gestalten" corresponds to the category of "logical operations" in the context of genetic epistemology).

It may be observed that, in the last analysis, and despite their inherent differences, all configurations are psychological configurations, since all objects are known through the psychological objects. And this fact, namely that all cognition is essentially a psychological process, and that the psychological dimension extends pervasively throughout all our experience, leads us back to the consideration of the old epistemological problem (first stated in Greek Philosophy and later by Kant): If everything that I know is given to me as the contents of my consciousness, then how can I possibly arrive at the assumption of the reality of the external world which presumably lies outside my consciousness? The answer of gestalt epistemology to this ancient problem may be stated in terms of the hypotheses of isomorphism and of constancy.

The epistemological triad (consisting of the perceiver, the percept, and the object of perception) is preserved in the context of gestalt epistemology without any reduction in the number of its elements. It is no longer maintained here, for example, that the percept and the object of perception are identical, since perception is a photographic process, and that consequently we have a direct knowledge of the external world. Nor is it maintained here, on the other hand, that the object of perception is identical with the percept, since we only know our own perceptions of the external world, and that consequently the world is our very image of the world. The truth is to be found somewhere between these two polemic viewpoints: For, what is valid in objectivism is that there is sufficient evidence for *object constancy*; and what is valid in subjectivism is that there is sufficient evidence for *critical interference*. Accordingly, the underlying principle of gestalt epistemology may be stated as follows: While the properties of the "phenomenal objects" vary, these objects nevertheless manifest a phenomenal constancy, from which the properties of the corresponding "transphenomenal objects" may be inferred. The qualitative variations of the phenomenal objects are the result of a set of critical interferences (consisting of physical, physiological, and psychological intervening factors) which are susceptible of theoretical compensation. Having discussed the general problem of object constancy from the phenomenological standpoint in the preceding chapter, here we shall examine the phenomenon of color constancy as a special case of it. This phenomenon consists of the fact that the perception of the chromatic color of an object remains constant under the variations of the intensity of projected light; since the visual receptor, apparently looking upon the bright but shaded color as well as the dark but illuminated color with a tranquil discrimination, corrects the proximal data by a proportionate distribution of the total quantity of light between color and brightness. The phenomenon of color constancy has been studied by D. Katz (163) and its epistemological significance has been examined by K. Duncker (79). In any case, this "filtering" of perception provides a basis for the *intersubjectivity* of perceptions. For, the intersubjectivity of experience, that is, the common knowledge of the same object possessed by different subjects, may be logically based upon the constancy of the object of experience. It follows that the degree of the intersubjectivity of knowledge varies directly with the degree of object constancy and inversely with the amount of critical interference: Thus objective knowledge (e.g. logic) builds its home on the bedrock of permanent constancy, and where critical interference prevails there also prevail conflicting viewpoints (e.g. aesthetics).

Following the epistemological path from the problem of objective knowledge to the problem of truth, we arrive at the *gestalt theory of truth* and its verification. The epistemological limitation of the classical conception of truth (correspondence theory) is well-known: According to this conception, propositions are true when they correspond with their objects of reference, and false when they fail to correspond with them; but the representative theory of perception, which this classical conception presupposes, renders the direct verification of the alleged correspondence, between the object and its description, logically impossible. Further, from the gestaltist standpoint, there is another limitation inherent in this conception: Namely, a proposition may be true with respect to a fraction of a situation but not true with respect to the situation as an integrated whole. Generally speaking, any case of "point-correctness" involves this logical limitation. In view of these limitations of the classical conception, gestalt epistemologists have undertaken a reformulation of the theory of truth. This reformulation, in which the concept of structure plays a basic role, may be stated summarily as follows: Propositions are true when they describe objects within a structural context, and false to the contrary. Relative to this conception of truth, M. Wertheimer (132) and W. Köhler (170) have established parallel dichotomies. Köhler has described the distinction between the "correctness" of an elementary description and the "truth" of a structural description. And Wertheimer, noting the logical difference between the "piece" (isolated element) and the "part" (element-in-relation), has formulated two sets of truth-values respectively: The "piecemeal truth-values" (f and t) and the "real truth-values" (F and T) (Thus a point-correct proposition will have the two possible truth-values, tF and tT, and a point-incorrect proposition will have the two possible truth-values, fT and fF). Generally speaking, then, there are two levels of truth, the elementary level and the structural level; and these levels of truth are represented by the "true-to" propositions and the "true-of" propositions respectively. Accordingly, the verification of hypotheses may be processed at the two levels of elementary correctness as well as structural validity. The logical implication of the gestalt theory of truth for the methodology of the natural sciences is evident: The complementary methods of analysis and synthesis both constitute the indispensable pathways to scientific truth. The consequences of the gestalt theory for the realm of values are far-reaching: Thus, for example, the case for the logical place of values in a world of facts can be based upon such a synthetic conception of truth (cf. Köhler (170)). And so it is that, through the winding path of epistemology, gestalt psychology brings back to us, as a contribution to the naturalist conception of human nature, those higher values that have been hitherto screened out by the statistical methods of experimental psychology.

Genetic Epistemology

European genetic psychology has developed the general theory of a "genetic epistemology" (*épistémologie génétique*) on the basis of the empirical genetic studies of thoight processes. It is maintained that the genetic theory of thinking entails the hypotheses of genetic epistemology; and Piaget (262) (265) (275) has rendered explicit these implications with characteristic skill and in great detail. The comparative review of genetic epistemology to be presented here shall be confined to the latter's positive contributions to the psychology of science, making only sundry references to its polemical paraphernalia which reverberate the polemical theses of genetic psychology discussed previously.

According to the genetic psychologists themselves, genetic epistemology may be contrasted to philosophical epistemology, by describing them as "descriptive epistemology" and "normative epistemology" respectively. However, this description is not exactly correct, and it is for that reason somewhat misleading. For it is not really the case that philosophical epistemology, either in its objectives or in its methods, is a normative discipline (e.g. ethics). And from the plain fact that philosophical epistemology contains a variety of conflicting viewpoints, it by no means follows that these viewpoints are essentially arbitrary prescriptions without rational and empirical evidence. Consequently, in contrasting genetic epistemology with philosophical epistemology, we shall retain our earlier distinction between their perpectives: Namely, that the perspective of the former is longitudinal, and of the latter transverse, while both kinds of epistemology remain essentially decriptive in nature. For philosophical epistemology investigates the nature and scope of knowledge, while psychological epistemology investigates the evolution of the nature of knowledge. And dividing the psychological task between them, gestalt epistemology and genetic epistemology have undertaken the investigation of cognitive "configurations" and "operations", with relative emphasis, respectively.

The theoretical objective of genetic epistemology may be described as the psychological study of the evolution of the sciences as a function of time and equilibrium. However, the primordial beginnings of scientific thought, as well as its ultimate termination, remain outside the explanatory range of genetic epistemology the hypotheses of which are based upon purely empirical, psychological, foundations. Hence Piaget (265-I: p. 12) writes: "If the nature of scientific knowledge in general is still a philosophical problem, for it is necessarily connected with all general questions, it is doubtless possible, by placing oneself *in medias res*, to delimit a series of particular and concrete questions to be collectively expressed: How do the sciences develope?" Accordingly, two forms of genetic epistemology have been distinguished by Piaget (275): (1) Special genetic epistemology: The study of the successive states of the contents of any given science as a function of its conceptual evolution; hence, it is described as "the positive science, empirical as well as theoretical, of the formation of positive sciences". (2) General genetic epistemology: The study of the processes and forms of the evolution of the general framework of scientific knowledge. The basic postulate of genetic epistemology, both special and general, is that every scientific conception has a psychological origin and a psychological history, and that the latter always terminates in a state of psychological equilibrium.

It has been noted previously that there is a parallelism between the perspective of genetic psychology and of genetic biology. It is to be expected, then, that the methodology of genetic epistemology should bear an analogical relationship with the methodology of comparative biology. Accordingly Piaget (265-I: p. 14) makes the following methodological observation: "From this point of view, all knowledge implies a structure and a function. The study of a mental structure constitutes a kind of anatomy, and the comparison of the diverse structures is comparable to a sort of comparative anatomy. The analysis of the functioning corresponds, on the other hand, to a kind of [special] physiology, and, in the case of common functions, to general physiology. But, before coming to the general physiology of the mind, the comparative anatomy of mental structures is the immediate task." The methodology of genetic epistemology may be analyzed into two complementary methods: (1) The longitudinal analysis of scientific conceptions from the standpoint of genetic psychology; (2) The transverse analysis of the structure of scientific thought, in general, at its various historical levels of psychological progression and equilibrium.

As a result of the investigation of the nature of scientific knowledge, by means of its special methodology, genetic epistemology has arrived at a set of general hypothetical results (cf. Piaget (265)):

(1) The hypothesis that the evolution of the sciences is regulated by the law of relative equilibrium. More precisely, every stage in the development of scientific thought, having a general logical structure which entails a psychological structure, is characterized by an appropriate degree of relative equilibrium. Consequently, when the logical structure of a given stage of scientific thought is assimilated in the logical structure of a succeeding stage, which is theoretically more general, it attains a relatively greater degree of equilibrium. For the analysis of the concept of equilibrium, which this hypothesis presupposes the reader may be referred to the chapter concerning the genetic theory of thinking.

(2) The hypothesis that all natural sciences possess a logical structure, and that, consequently, the science of logic is genetically prior to all the natural sciences. The theoretical results of the genetic theory of thought processes imply this hypothesis; and, accordingly, Piaget (265-III: pp. 11–12) writes: "All the elementary notions which constitute the startingpoints of the different varieties of scientific thought, from mathematics [and physics] to biology and psychology, assume in their initial form a simple logical structure consisting of operational groupings." This hypothesis of genetic epistemology is implicitly reinforced

by the phenomenological trend in contemporary philosophy of science which is devoted to the study of the logical structure of science.

(3) The hypothesis that there is an epistemological parallelism between the genetic histories of the various natural sciences. This parallelism consists of the fact that three epistemological stages may be discerned in the evolution of the sciences. These may be described as follows: (i) Epistemological explanation with reference to the object of knowing exclusively (e.g. classical empiricism and positivism); (ii) Epistemological explanation with reference to the knowing subject exclusively (e.g. classical rationalism and existentialism); (iii) Epistemological explanation with reference to the relationship between the knowing subject and the known object (e.g. transcendentalism and phenomenology). There appears to be, evidently, an homological relationship between these epistemological stages and the psychological stages of thought processes (cf. Chapter 5: II).

(4) The hypothesis that there exists a permanent "circle of sciences": Thus the phenomena of psychology have a biological dimension, the phenomena of biology have chemical and physical dimensions, the objects of physics have a mathematical dimension, and the objects of mathematics and logic have a psychological dimension, and consequently, the former sciences may be explained with reference to the latter sciences. Genetic epistemology attempts to deduce the circle of the sciences from the "epistemological circle" of the subject and the object. The latter, first described by the Danish epistemologist H. Höffding (140), consists in that: The subject, by his perceptual framework, transforms the object; and the object, as a percept, transforms the psychological medium of the subject. It may be observed that, if the circle of sciences constitutes the logical entailment of the epistemological circle, then it too constitutes a logically vicious circle. And the only logical way out of this theoretical entanglement appears to be the hypothesis of the parallelism of sciences (cf. Chapter 9: II). In this respect, it may be noted that genetic epistemology, despite prolonged oscillation between the hypotheses of reductionism and parallelism, arrives at the conception of epistemological parallelism in the last analysis. The analysis of the concept of "reductionism" reveals its two forms: Reduction by "interdependence", and reduction by "correspondence". And the concept of parallelism is presupposed in both of these forms of reductionism, indirectly in the former case and directly in the latter case. And, if analysis were to be continued, the hypothesis of parallelism, which is based upon the phenomena of the levels of

the sciences, would lead us to the general conception of phenomenological levels in nature.

Concluding Remarks

It may be observed that, from a comparative point of view, genetic epistemology and gestalt epistemology bear a theoretical relationship to each other. This theoretical relationship is threefold and remains deeply rooted in the conceptual contents of the two theories. In the first place, genetic epistemology remains obliquely indebted to gestalt epistemology with respect to the employment of the concepts of "structure" and "equilibrium", since both theories conceive knowledge to be structural in nature with relative degrees of equilibrium. But since we have previously examines these concepts, their origin in gestalt psychology and their adaption in genetic psychology, we shall say nothing more here. In the second place, these epistemological theories, which have developed upon empirical foundations as the theoretical epiphenomena of experimental psychology, contribute toward the establishment of a "structural epistemology". It follows that together they reject the "atomistic epistemology" of classical empiricism (Locke and Wundt) as well as of modern behaviorism and positivism. Accordingly, while accepting the Kantian thesis, to the effect that from the fact that all knowledge originates *with* experience it does not follow that all knowledge originates *in* experience, psychological epistemology considers the abstract categories of cognition themselves to be the product of the natural history of the organism. In the third place, there prevails a theoretical complementarity between the two epistemological theories with respect to their "configurational "and "operational" perspectives, that is, with respect to the relative emphasis upon form and function, respectively. Finally, both theories, as two main variations of psychological epistemology, reinforce the perspective of the "realistic epistemology" which we have sketched in the preceding chapter; and implicitly contribute to the perspective of the "realistic philosophy of science" which we shall sketch in the remainder of the present chapter.

III. PHILOSOPHY OF SCIENCE AS THE MORPHOLOGY OF SCIENCE

Our examination of the experimental phenomena and theoretical concepts of empirical psychology (especially the genetic and the gestaltist trends) has led us to some necessary considerations concerning a realistic reconstruction within the framework of the philosophy of science. For, if these psychological trends have shed new light upon the problems of the "psychology of science", then its logical complement, the "philosophy of science", cannot remain unaffected by their epistemological consequences. Moreover, it is now apparent that both neopositivism and existentialism have failed to assimilate this new evidence; and that, consequently, both remain inadequate frames of reference for the objective interpretation of science. In the contemporary philosophy of science, the work of Whitehead (365), Cassirer (60), and Hartmann (125), which have contributed towards the analysis of the "structure of science", beyond the mere "grammar of science", have led to a realistic conception of the nature of science. More recently, the work of Feigl (88) and of Törnebohm (343) have reintroduced, in the realm of the physical sciences, two versions of the realistic philosophy of science, that of "semantic realism" and of "logical realism", respectively. Partially parallel to these viewpoints, in the realm of the biological sciences, the studies of Strasser (330) in the University of Nijmegen, and of Marjorie Grene (115) in America, have sought the path toward a transcendent "third alternative" beyond operational physicalism as well as subjectivism. The protracted path of our investigation, throughout indebted to the above philosophical trends, has led us to a morphological conception, in the light of "phenomenological realism", to the elucidation and vindication of which we must now turn.

In the following pages we shall endeavour to sketch the outlines of a philosophy of science from the realistic standpoint. The transcendental objective of this metaphysical framework will be to provide a logical place for the "objective realm" as well as the "subjective realm" of experience, for the quantitative data as well as the qualitative phenomena of the natural sciences. However, our sketch is primarily a prolegomenon to the philosophy of the biological and psychological sciences; and its application to the physical sciences is necessarily confined to the structural continuity of the latter. In any case, we shall be concerned here with the natural sciences, and not at all with the "social studies" in any sense (not to say the "social sciences" to avoid the fallacy of simplism). Finally, this prolegomenon is necessarily intended to furnish the outline of a programme rather than the blueprint for a complete system.

From the realistic standpoint, strictly speaking, the philosophy of science consists of the logical study of the morphology of science. There is an analogy between the realistic perspective and the naturalist perspective: As the naturalist studies the comparative morphology of the phenotype as well as of the genotype, so the realistic philosopher studies the varieties of phenomena as well as their inherent logical structures. From the standpoint of phenomenological realism, the two aspects of the natural sciences may be described as follows: (1) The *phenomenal dimension* which comprises the inter-science variation of subject-matter and methodology; (2) The *logical dimension* which consists of the homologies and dichotomies between the logical structures of the various sciences. Accordingly, corresponding to these aspects of science, the philosophy of science acquires a twofold objective: The first being examination of the phenomenal variations of the sciences (this has been hitherto neglected by the orthodox schools of contemporary philosophy); and the second being the examination of the logical structures of the sciences and their ramifications. It may be observed that, when the philosophy of science adopts this double perspective, synthesizing empirical analysis with logical analysis, it becomes, properly speaking, the "morphology of science": That is, the systematic integration of the phenomena of the various sciences, without any arbitrary reductionism, within a realistic theoretical framework. It may be noted, further, that the conception of the philosophy of science *as the* morphology of science is transcendent to the polemic perspectives of monolithic schools. It follows that phenomenological realism, in contrast to neopositivism, does not consider the study of the "grammar of science" as the highest, or even the sole, objective of the philosophy of science; although semantics and syntatics will be properly retained in the analytical repertoire of realism. Again, this viewpoint, unlike existentialism, does not abandon itself to the wooing of subjective phenomena with a thoroughgoing neglect of the objective phenomena of the natural sciences. In this respect, there is indeed a common bond between realism and positivism, in that both theoretically strive to remain consistent with the contents of the natural sciences. Phenomenological realism, then, studies the variations of phenomena as well as their logical forms, that is, the phenomena of the sciences relative to the logic of sciences. We may now describe these two complementary phases of the philosophy of science.

The Concept of Phenomenological Spectrum

The path followed by the philosophy of science, during the last three decades, appears to have brought it to a state of logical stalemate. For, while contemporary philosophy has sought to achieve the theoretical "unification of sciences", it has consistently failed, because of the recurrence of a set of empirical and theoretical counterevidence. The realistic philosophy of science, too, shall aspire to establish the "unification of sciences", but at a higher logical level than the phenomenal level sought by positivism. For positivism, maintaining the doctrine of logical conventionalism, seeks the unity of the sciences in their phenomena. However, as we have seen previously, this viewpoint gets involved in the paradoxes of operational reductionism. Realism, in contrast, recognizes the diversity of natural phenomena, in a systematic fashion, and studies the transcendental unity of their logical structure. Accordingly, contemporary philosophy of science stands in need of a new concept representing the diversity of the contents of the natural sciences, in contrast to the unity of their logical form, and we shall designate it the "concept of phenomenological spectrum".

The concept of *phenomenological spectrum* may be described as follows: The observation of natural phenomena reveals various realms, each containing various qualitative dimensions, and located at different phenomenal levels. The various natural sciences, with their respective qualitative and quantitative laws, correspond to the phenomenological levels of natural phenomena. This general conception is based upon both theoretical and empirical evidence which we have repeatedly encountered previously. Consequently, it is to be expected that specific manifestations of the same general conception are to be found in the special contexts of the various sciences. Thus, there are the microscopic and macroscopic levels in physics (Margenau (218) and Nagel (234)); the concept of "integrative levels" in biology (Rensch (296) (300) and Novikoff (238)); the concept of "behavioral spectrum" in psychology (London (204)); and, in the context of epistemology, the conception of "psychophysical levels" with its alternate representation of human nature as a physiological system and as a psychological system (Fechner (1860) and Strasser (330)). In view of the fact that there are various kinds of empirical and theoretical levels and sublevels, a logical analysis of the conception of level becomes necessary. Relative to this, M. Bunge (50) has provided us with a valuable semantic analysis. If the Bungean analysis and this author's analysis of the conception of *level* (to be given in the following) manifest several points of coincidence, despite essential differences, it is because both analyses employ a logical, rather than a linguistic, frame of reference. The relationship between these two analyses may be described as that of theoretical complementarity: For, without reproducing here Bunge's formal and symbolic representation of the properties of levels, our analysis contains instead a realistic classification and representation.

The concept of phenomenological spectrum may be described, precisely, by means of a logical analysis of the phenomenology of levels, with respect to their variation as well as integration, as follows:

(I) Ontological Levels:

The levels of natural phenomena, taken by themselves, as the objects of the natural sciences.

(1) Homogeneous Levels:

The levels of quantitative variation within a given qualitative dimension.

(a) Levels as degrees of qualitative intensity or quantitative density.
Illustration: psychophysical measurement (Fechner).

(b) Levels as degrees of structural complexity.
Illustration: simple and complex machines operating on identical principles of mechanics and dynamics.

(2) Heterogeneous Levels:

The levels of qualitative variation along a given series of natural phenomena.

(a) Levels as emergent entities (wholes).
Illustration: The phenomena of "psychological gestalten" and "physical gestalten" (Köhler), of the "integrative levels" in biology (Dobzhansky and Novikoff), and of "isomerism" in chemistry (Pauling).

(b) Levels as emergent strata (layers containing sets of wholes).
Illustration: The "psychogenetic levels" in psychology (Baer and Piaget); and the "tree of life" in evolutionary biology (Darwin and Rensch).

(II) Epistemological Levels:

The levels of our conceptual knowledge of the natural universe as they are reflected by the logical levels between and within the natural sciences.

(1) Levels as degrees of analytical depth.
Illustration: The range of analytical depth, in the context of the theory of evolution (inheritance of traits), from the praxis hypothesis (Lamarck) to the pangenesis hypothesis (Darwin) to the general genetic theory (Weismann) to the special genetic theory (Dobzhansky).

(2) Levels as degrees of synthetic generality.
Illustration: The law of the inverse variation of intension and extension in logic; the concatenation of concept—hypothesis—theory—science—philosophy of science.

(3) Levels as the relative epistemological transcendence of the natural sciences, corresponding to the relative ontological transcendence of the natural phenomena (cf. the realistic classification of the sciences).

The interrelationship of the phenomenological levels may be described with reference to their "continuity" and "divergence".

There is a permanent *continuity* between the various phenomenal realms, since common qualitative dimensions appear to be pervasive throughout all levels. Hence, in some respects, the borderline of demarcation between the phenomenal levels appears to have an indistinct nature. Theoretical biology has illustrated that, at the points of transition between the adjacent levels, there are the mesoforms and nascent functions, which, beyond the point of transition, are manifested as a novel system of traits in the context of a completed reintegration. However, if the bimorphic case of the "vegetative animal" and the "carnivorous plant" represent biological continuity, the biological dichotomy between the plant life and the animal life, at the higher levels, appears to be equally significant. While the continuity of traits are woven into the fabric of phenomenal levels, the latter are given texture and color by the divergence of traits.

The *divergence* of phenomenal levels may be explained with reference to the "emergence" of novel traits in the higher levels. An ontological trait may be described as "emergent", relative to a given epistemological level, when the former partially or wholly transcends the framework of the theoretical analysis provided by the latter (cf. Chapter 7: II). It is in this sense that the psychological and the biological levels of phenomena are to be considered as divergent from the physical and mechanical levels. Therefore, it is not merely a matter of quantitative complexity, as we ascend the scale of phenomenological levels, but a matter of qualitative variation. More precisely, the natural laws that regulate the objects of the biological sciences are logically different from the laws that regulate the objects of the physical sciences. Consequently, the special phenomena of psychology and biology may be regarded as being transcendent to the analytical framework of physics. It will be sufficient to give a specific illustration here: The principle of entropy is a law of thermodynamics, according to which the dispersion of energy in the physical universe is both uniform and irreversible; but this principle has no application to the biological organisms living in the biological world, the latter being the product of the selective and reversible process of metabolism. Accordingly, while the history of physical science describes the frustrated abdication of the ideal of constructing a "perpetual motion machine", the cyclic transformations of biological systems constitute the equivalent of the "perpetual motion machine" in the context of the biological science. And, perhaps, it is to this biological conception of the "cycle of life" that the genesis of the philosophical idea of the "universal organism" (Fechner) and of "metaphysical immortality" (Whitehead), whatever their epistemological weight, are to be traced. Taking our illustration a step further, it may be noted that, within the science of physics proper, there exist several sublevels with their respective qualitative laws: Thus the level of macrophysics possesses a set of laws which does not have application to the level of microphysics and conversely (The "principle of inverse square" and the "principle of indeterminancy" are the outstanding cases). In view of such evidence, it would be strange indeed if the mutations of biology and the permutations of psychology in fact were regulated by the principles of physics. It may be concluded, then, that the phenomenological independence of the biological sciences from the physical sciences, despite their continuity in some respects, appears to be grounded in the logical structure of the natural universe itself.

The continuity and divergence of levels, in the context of the phenomenological spectrum, are to be viewed as limiting properties. Consequently, there is in reality but a partial continuity and a partial divergence; and, hence, a *partial parallelism* between the levels. To the extent that there is a continuity between the phenomenal levels, the methods of physical measurement are applicable to psychological phenomena; and to the extent that there is a parallelism between the natural sciences, methodological adaptation and cohabitation between the sciences is possible. It is not to be attributed entirely to an accident in intellectual history that some of the basic concepts of the physical sciences have found their way into the universe of the biological sciences, and of the biological sciences into the realm of the humanities. Concepts like "system" and "equilibrium" represent the former group, and concepts like "organism" and "function" illustrate the latter group. However, the epistemological interlacing of the contents of the natural sciences, being based upon structural continuity, is not to be mistaken for structural identity. Strictly speaking, it is a case of epistemological analogy rather than a case of epistemological homology. For, as we have seen, continuity is one aspect of the natural phenomena, divergence being the other aspect; and, consequently, the consideration of one aspect to the neglect of the other, would retard, rather than enhance, the advancement of the natural sciences. The partial parallelism of the sciences implies that there is a theoretical complementarity between the sciences; for, ontologically viewed, the sciences investigate the various levels of reality respectively.

The concept of *phenomenological spectrum* entails the hypothesis of *epistemological spectrum.* For, the epistemological analysis of ontological entities, specifically, the entities which constitute the objects of the natural sciences, at the groundlevel of discursive discourse, yields a fourfold schema:

(Ω_1) *phenomenal objects* (called "sense-data" in old-fashioned empiricism) which consist of the perceptual and eidetic representations of the external world.
(Ω_2) *transphenomenal objects* (including "physical things") which have the alleged attributes of relative constancy, concreteness, and intersubjectivity.
(Ω_3) *indices of measurement* (including "pointer-readings") which are the resultants of the experimental verification of the correspondence between the phenomenal and transphenomenal objects.
(Ω_4) *theoretical concepts*, which, as the abstract categories for phenomenal and transphenomenal objects, consist of "*generic entities*" (e.g. concept of "natural type" in biology and medicine) and "*inferred entities*" (e.g. concept of "engram" in psychology, of "negative sensation" in psychophysics, and of "weightless string" in classical physics).

The ontological manifold of the world of systematic experience, resulting from this epistemological analysis, may be summarily designated as follows: $(\Omega_1{}^{\smile}\Omega_2{}^{\smile}\Omega_3{}^{\smile}\Omega_4)$. The parallelism between this schematization and Törnebohm's "universal classes" is evident (excepting the critical fact that only his Concepts$_4$ in the context of V_4 qualify as abstract entities in our sense) despite terminological variation (cf. Törnebohm (343)). And this epistemological parallelism, derived from the complementary evidence of experimental psychology and relativity physics, respectively, confirms Feigl's earlier formulation of the groundprinciple of "semantic realism" (88): "(Immediate Experience) : (Commonsense World) = (Commonsense World) : (World of Theoretical Constructs)." However, when the universe of ontological entities is analyzed into four categories (instead of the standard three) their epistemological interrelationships manifest a more complex form. And the logical representation of this proportional relationship requires a synthetic formula: $((\Omega_1 : \Omega_2) :: (\Omega_3 : \Omega_4))$

We shall maintain that this formula, being synthetic, is not compressible: That is, its last term is not reducible to its third, nor its second term to its first.

It has been argued by the exponents of the verifiability theory of meaning (notably Carnap) that all propositions about transphenomenal objects (Ω_2) could be eliminated by translating them into propositions about phenomenal objects (Ω_1) which contain nothing but a set of *Protokolsätze*. That it is not possible to carry out this programme, in principle, is evident from the fact that verificatory propositions about the *context* of the protocols themselves (Ω_1) necessarily contain reference to the *contents* of the external world (Ω_2). Thus, for example, the protocol proposition, "I see a green plant", when supported by the verificatory proposition, "If one possesses normal visual receptors, and looks in a given direction, under certain conditions of illumination, then one perceives an object resembling a green plant", presupposes a set of transphenomenal objects (like "visual receptors", "spatial direction", "conditions of illumination", and "object") in the objective context of verification. On this point the author is in complete agreement with Törnebohm (343: p. 170) despite differences in terminology: "Concepts$_2$ are related to concepts$_1$ by means of the propositions of the form '*If q then r*' where *q* states conditions of observations by means of concepts$_2$ and *r* contains concepts$_1$." This conclusion constitutes a special form of the general hypothesis–that "the factual and counterfactual conditionals concerning the data of immediate experience are deducible from the hypothetical assumptions about the laws and the facts of the 'real' world"–which had been formulated earlier by Feigl (88) in connection with the problem of existential commitment.

In the context of experimental psychology the representatives of behaviorism have argued, on the basis of the theory of operational definition, that theoretical concepts (Ω_4) are reducible to the indices of measurement (Ω_3) without remainder. However, since the possibilities of experimental measurement are infinite in number, strictly speaking, the process of verification would continue indefinitely, and consequently, the "operational definition" of the theoretical concept would remain permanently incomplete. And the effort to stop short of the ideal, by arbitrarily adopting a "workable "definition of the concept, on the basis of a given operation, would be logically cancelled off by a different and equally valid operation performed later. Accordingly, the "operational definition" of a psychological concept in the case of a given species of animals proves to be utterly useless, when two specimens with the "same" psychological state display different behavior, or, when the same specimen displays similar behavior as a result of "different" psychological states. The details of the behavior of animals in the cage have no place in this philosophical work: Suffice it to note that, when the white rat habitually expresses its multifarious emotions by a stereotyped response, then the operational behaviorist deserves his earned bafflement in the face of such allegedly "contradictory behavior". From the methodological standpoint, since the arbitrariness of the operational choice is without sufficient reason, in principle, the resulting "operational definition" remains without any logical basis whatever. And were it to be counterfactually assumed that the operational reduction of theoretical concepts were possible, by some such precarious means, then the very meaning of abstract entities will have been changed altogether, so that they would no longer serve as the essential factors of generalization in science.

The foregoing considerations, concerning the relationship of abstract entities to concrete entities, have far-reaching implications referring to the rôle of abstract entities in scientific explanation. These are: (α) That the operation of empirical inference, explaining the observable effects of a nonobservable process, requires the category of "inferred entities"; and (β) That the operation of empirical generalization, explaining the resemblance of phenomena and the phenomena of resemblance (including the resemblance of the exemplar to the examples), requires the category of "generic entities". On the basis of these implications, the general hypothesis of *epistemological spectrum* may be concisely formulated as follows: The degree in which a given theory is purged of the necessary incidence of abstract entities, the phenomenal realm being constant, is inversely proportional to the range of its scope of explanation. Referring to the synthetic formula derived from the epistemological analysis of the ontological manifold, $\{(\Omega_1:\Omega_2)::(\Omega_3:\Omega_4)\}$, the hypothesis of epistemological spectrum may be elucidated as follows: Granting that the four epistemological realms, $(\Omega_1 \smile \Omega_2 \smile \Omega_3 \smile \Omega_4)$, represent the *phases* of the scientific knowledge of the external world, it follows that, without the existence of abstract entities (Ω_4) in the context of natural sciences (*a fortiori* in the context of the philosophy of science), the lower realms of Ω_3 and Ω_2 (and therefore Ω_1), which logically presuppose Ω_4 as a transcendental matrix, would remain unexplained. Thus, at any given phenomenological level, the elimination of abstract entities from scientific theory renders the *epistemological spectrum*, representing the disparity between the dimension of concrete protocols and the dimension of general concepts, eclipsed at the higher end. In the last analysis, *in* a world of facts there is no room for a theory *of* the world. My fundamental thought, then, is that abstract entities (Ideas) are to be regarded as the essences (*Substanzbegriffe*) and the concrete entities (facts) as the limits (*Grenzbegriffe*) of scientific theory, if the very possibility of knowledge proper is to be preserved.

The Logical Structure of Science

The logical transition from the conception of the phenomenological spectrum to the comprehension of the logical structure of science is evident: Since the phenomenal contents of science are given within the framework of the logical structure of science, philosophical analysis begins in the former and terminates in the latter. In the following we shall outline an abstract analysis of the functions of the philosophy of science relative to the various dimensions of the logical structure of science. The resulting framework may be described as a "metaphysical schema" in a profound sense. For, the *logical structure* of science may be described as the transcendent framework of science relative to its *phenomenal contents*. The transcendence of the logical structure of science is to be inferred from the fact that, while the natural sciences are heterogeneous with respect to their phenomenal contents, they are isomorphic with respect to their logical forms. The logical form of science remains unchanged, while the phenomenal contents of science change.

It is generally maintained that every scientific theory has a foundation, a logical structure, and a set of theoretical implications. Accordingly, the logical examination of the scientific theory by the philosophy of science is said to consist of a threefold process: (a) the analysis of the factual and logical foundations of the theory; (b) the analysis of the logical structure of the theory with respect to its internal consistency; (c) the analysis of the logical consequences of the theory. The analysis of a theory, based upon this simple model, which is derived from the natural history of knowledge, appears to be adequate, in many cases, especially in the area of the humanities. However in the realm of the natural sciences, with a logical structure of relatively high degree of complexity and intricacy, the function of the philosophy of science acquires a corresponding degree of complexity and theoretical depth.

The logical structure of science may be analyzed into the following categories: (a) the fundamental postulates of science; (b) the theoretical and experimental methodology of science; (c) the basic concepts of science (e.g. inferred entities); (d) the empirical and rational hypotheses and theorems of science; (e) the lower level and higher level laws of science; (f) the general theoretical systems of science. The general function of the philosophy of science, relative to the examination of the logical structure of science, involves, in its rudiments, a sixfold analysis-synthesis. This rudimentary set of functions, which we shall collectively designate as the methodology of the philosophy of science, will be described as follows:

(1) *Transcendental analysis*: Consisting of the logical examination, by means of a regressive analysis, of the basic postulates and presuppositions of science. Illustration: The conception of the uniformity of nature, the conceptions of space and time, and the conception of causality. The guiding principles of the transcendental analysis are:

(a) The "principle of reverse implication" to the effect that every specific scientific conception is embedded in a general scientific conception as its logical precondition. (b) The "principle of sufficient reason" to the effect that every scientific conception is derived from an empirical or logical ground to which it may be retraced.

(2) *Methodological analysis*: Consisting of the logical examination of the methodology of science. Illustrations: The experimental methodology for the study of atomic and serial phenomena (physical sciences) and of organic and cyclic phenomena (biological sciences), and the rational methodology of the quantitative aspect of reality (mathematical sciences). The guiding principles of methodological analysis are: (a) The "principle of methodological complementarity" to the effect that the natural sciences, corresponding to the different levels of natural phenomena, must employ parallel but different sets of methods. (b) The "principle of contradiction" to the effect that the internal coherence of a science, as well as its external correspondence to nature, constitutes the basic criteria of truth.

(3) *Semantic analysis*: Consisting of the phenomenological analysis of the basic concepts of science with respect to their objective reference. Illustrations: The descriptive classificatory categories (phenomenological types), the class of inferred entities, and the set of higher level explanatory concepts. The guiding principles for the semantic analysis are: (a) The "principle of phenomenological analysis" which prescribes the investigation of the structure of concrete phenomena and abstract configurations as the objective reference of the language of science (This principle stands in sharp contrast to the method of "linguistic analysis" which consists of the superficial transcription of given descriptions from one language to another). (b) The "concept of realistic spectrum" according to which there are various levels of natural phenomena and these constitute the objective references of the descriptions of the various natural sciences. (c) The "principle of phenomenological verification" according to which the sufficient condition for meaningfulness consists of the experience of a perceptual configuration or a conceptual configuration (This principle stands in sharp contrast to the positivist principle of verification which limits meaningfulness to operational testability).

(4) *Syntactic analysis*: Consisting of the logical examination of the logical interrelationships of the various forms of thought expressed by hypothetical propositions. Illustrations: The experimental and theoretical hypotheses of the empirical sciences, and the deductive theorems of

the mathematical sciences. The guiding principles for the syntactic analysis consists of the valid models and laws of reasoning provided by classical and modern logic, namely, the methods of inductive inference and the methods of deductive proof.

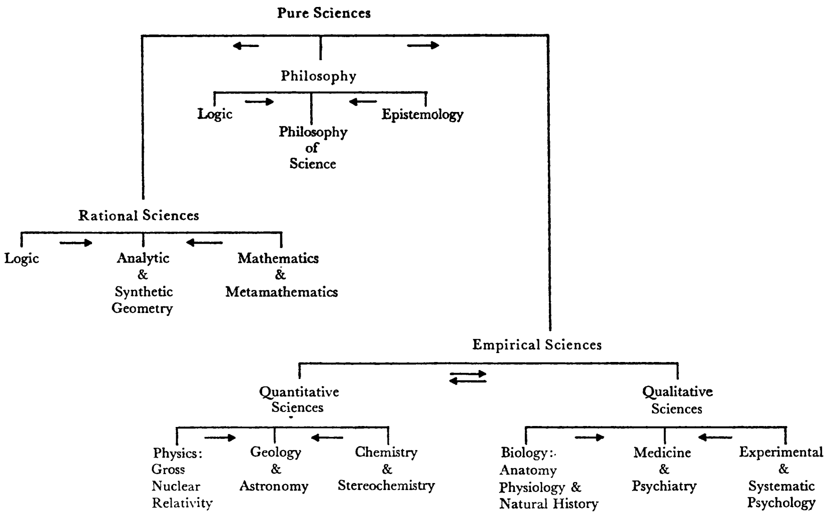
(5) *Dialectic analysis*: Consisting of the logical analysis and epistemological examination of the conflicting laws and theories of the sciences. Illustrations: The behaviorist theory and the gestalt theory of cognitive processes in psychology, the reflex theory and the autonomic theory in ethology, the somatogenic theory and the psychogenic theory in medicine. The guiding principles for the dialectic analysis consist of: (a) The "principle of scope" to the effect that the relative epistemological worth of a given theory, its logical simplicity being constant, is directly proportional to its scope of explanation. (b) The "principle of analogy" to the effect that, since a partial parallelism holds between the natural sciences, the epistemological examination of conflicting theories in a given science may be analogically based upon evidence from the adjacent sciences.

(6) *Transcendental synthesis*: Consisting of the inference of the logical consequences of scientific theories and the integration of the complementary and conflicting theories in the context of a general cosmological framework. The regulative principles of transcendental synthesis are: (a) The "principle of dialectical synthesis" according to which the logical integration of the partial truth of conflicting theories results in a synthetic theory with a higher degree of truth. (b) The "principle of transcendental synthesis" according to which, the structure of the universe being constant, there is only one true cosmology wich is susceptible of discovery by the systematic and progressive integration of the complementary theories of the natural sciences. At this level of transcendental synthesis the philosophy of science profoundly approaches speculative philosophy (metaphysics). For, as Whitehead (365: p. 4) has described it, "Speculative philosophy is the endeavour to frame a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted."

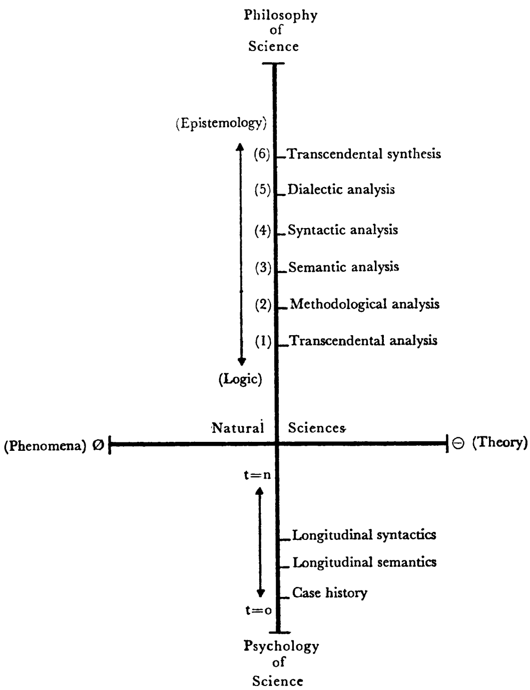
We have noted that the function of the philosophy of science, conceived as the morphology of science, consists of the interpretation of the phenomenal content, as well as the examination of the logical structure, of science. However, as Cassirer (60: p. 203) has observed, "We cannot, in our phenomenology and critical theory of knowledge, speak of 'matters' and 'forms', 'phenomena' and categorical 'orders', being 'combined' with one another. On the other hand, we not only can but must determine every particular in respect to such orders, if experience is to come into being as a theoretical structure. It is participation in this structure that gives to the phenomenon its objective reality and determinacy." The relationship between the conception of the "phenomenological spectrum" and the conception of the "logical form" of science may be summarily described as follows: The former provides a basis for the levels and variations of the natural sciences; and the latter provides a basis for their logical unification. It follows that the realistic philosophy of science necessitates a revision in the general classification of the sciences (cf. Figure): Here the "empirical sciences", as a subcategory of the "pure sciences", represent two families of natural sciences: The "quantitative sciences" and the "qualitative sciences", comprising of the physical and the biological disciplines, to be differentiated on the basis of the primary or secondary role of mathematical and morphological methods in their respective contexts. Further, from the phenomenological standpoint, the philosophy of science maintains a complementary relationship with the psychology of science, the common link between them being epistemology as the theory of cognition proper, and this relationship manifests itself in the logical complementarity of the perspectives of "transverse analysis" and "longitudinal analysis" (cf. Figure VI). Consequently, the realistic philosophy of science comprises, from the logical point of view, a *four-dimensional matrix*: For, in this context, the theoretical scope of the philosophy of science ranges, horizontally, between the perspective of phenomenological spectrum and of logical structure, and vertically, between the perspective of longitudinal analysis and of transverse analysis. It is to be hoped that within such a realistic framework, the progenitor of which is found in the systematic conceptions of N. Hartmann and A. N. Whitehead, all the classes of natural phenomena would find their logical place.

Realism and Positivism

The prolegomenon to the realistic philosophy of science, sketched above, contains certain theoretical consequences relative to the various contemporary interpretations of the nature of science. Two viewpoints especially, namely neopositivism and existentialism, stand in sharp contrast to each other with respect to their approach to science and its problems. But we shall say nothing here about the existential philosophy, in view of the fact that it has rejected the authenticity of scientific methodology and has rejected the epistemological validity of the natu-



Outline of a realistic classification of the sciences.
(Note: The arrows designate conceptual relationships between the sciences)



Schema of the realistic philosophy of science ral sciences (cf. especially the French School represented by J.-P. Sartre). We do not intend to mean, of course, that in this case "de principii non disputandum est"; but rather that, since existentialism remains essentially an "unscientific philosophy", with respect to its methods as well as its contents, it cannot be expected to contribute to the enlightenment of the nature of science. It is to positivism that belongs the merit of taking natural science seriously; even though, as we have hinted previously and shall presently elaborate, it is in some respects seriously mistaken in its interpretation of the sciences (especially the biological and psychological sciences). Our critical observations here, being necessarily of a general nature, will be confined to the positivist philosophy of science, both in its "logical" and "linguistic" forms, for there is a continuity, represented by the principle of physicalism, which extends between the earlier and the later phases.

From the realistic stanpoint, the philosophical interpretation of the natural sciences by neopositivism involves two basic limitations: Strictly speaking, the first limitation is purely methodological, and the second limitation purely epistemological in nature.

The methodological limitation consists of the fact that the analytical repertoire of positivism is limited to three methods (namely: methodological analysis, semantic analysis, syntactic analysis). Of the six principal methods, which constitute the methodological framework of an objective philosophy of science, positivism is committed to the negligence of three (namely: transcendental analysis, dialectic analysis, transcendental synthesis). Thus essentially half of the total logical structure of science remains eclipsed from the positivist viewpoint. Accordingly, to the question, "Does science have metaphysical presuppositions?", a positivist typically answers negatively. It is overlooked that, *as a* theoretical system possessing a logical structure, science *is* a "metaphysical system"; for, logically speaking, *in* a physical context there is no logical space for a theory *about* that physical context (cf. Chapter 8: III). Similarly, to the question, "Does science have metaphysical implications?", positivists answer negatively. It is overlooked, again, that the logical path that leads from natural science to speculative philosophy consists of nothing but the abstract continuum rooted in the logical structure of science itself. So the logical progression of thought, from the epistemological *many* to the epistemological *one*, from the *how* of phenomena to the *why* of phenomena, from the logical *true-of* to the logical *true-to*, from ontological facts (*beings*) to ontological reality

(*Being*), necessarily begins in empirical science, and transcendentally terminates in speculative philosophy. Philosophy, in a profound sense, is the "science of science": The logical study of the fundamental principles of the sciences together with their remotest consequences being the proper task of the philosophy of science. However, consistent with the conventionalist tenet, positivism rejects the possibility of fruitful dialectic concerning the truth of fundamental principles. For, according to this viewpoint (Wittgenstein excepted), neither is science the topography of nature nor is the scientist the discoverer and mapper of reality (Hence the intense preoccupation of positivism with semantics and syntactics). In contrast realism maintains that: Reality, whatever its objective nature, lies essentially out there; natural science, however inadequately, does represent a theoretical picture of the natural universe; and the scientist, despite perennial methodological shortcomings, is primarily a discoverer and secondarily an inventor. These assumptions of realism are, not arbitrary postulates, but based upon rational and empirical evidence (cf. Chapter 9: I). And these observations may by no means be interpreted to belittle the value of the analytic methods practiced in the context of the positivist philosophy of science, but rather to defend the case for the neglected methods. For this author is in complete agreement with the assessement made by Jørgen Jørgensen (Copenhagen) in his historical sketch of the positivist movement: "The very fact that we have grown accustomed to ask for the *meaning* of words and sentences and have found useful criteria has intensified our criticism of statements made by ourselves and by others and has thus furthered the critical attitude which, combined with inventiveness and imagination, is the basic condition for a sensible approach to the practical problems of our day and to the promotion of scientific knowledge." The methods of semantic and syntactic analysis constitute the necessary condition for the preservation of scientific knowledge and philosophical speculation against the contagion of ambiguity and amphibology. It is for this reason that semantics and syntactics are not the inventions of the contemporary philosophy (although they have attained a relatively high degree of refinement recently): Indeed the writings of Plato and Aristotle (not to mention Kant) display a pervasive employment of these analytical methods; and, in this respect, Wittgenstein and Carnap may be included among their faithful disciples. However, when semantics and syntactics are conceived of, not as the logical analysis of meanings (ideas), but as the linguistic analysis of words (usages), as it is the case with "linguistic positivism", then there is ground for skepticism and need for critical reconstruction.

The epistemological limitation of positivism consists of the fact that it neglects, after having explicitly denied, the logical strata of natural phenomena. Consequently, being committed to the doctrine of physical reductionism, this philosophy leaves no logical space for the concept of phenomenological spectrum. To this epistemological limitation is to be traced the root of the positivist principle of verification and the concomitant principle of operationism. We shall say nothing here about these two principles the paradoxical nature of which we have examined previously (cf. Chapters 8 and 9). Suffice it to note that positivism, by horizontally delimiting the meaning of meaning to the level of atomic facts (*Protokolsätze*), arbitrarily excludes the structural levels of phenomena. For this reason, the positivistic conception of the "unified science", being based upon the hypothesis of the monolithic reduction of the phenomenal contents of the various sciences, remains a misconception. For, as Professor Spiegelberg (326-II: p. 685) has observed, "genuine philosophy, and not merely phenomenology, has no reason and no right to ignore any authentic phenomenon, whatever actual or potential use its knowledge may have."

Despite the logical limitations of "logical positivism" (Early Wittgenstein and R. Carnap), its eventual transformation into "linguistic positivism" (Late Wittgenstein and the Oxford School) may be described as a logical retrogression rather than as a logical progression. The history of this retrogression can be traced from the original theses of "logical atomism" and "logical picture", as well as the "picture theory of language", to the recent theses of "semeiotic conventionalism" and "linguistic behaviorism". Concomitant with this transformation the analytical methods of positivism have been changed from those of "logical analysis" to those of "linguistic analysis". And, consequently, the positivist philosophy of science has come to be exclusively preoccupied with the "language of science" to the neglect of the "logical structure" of science. Accordingly, that a linguistic analyst should write a monograph concerning the psychological process of "dreaming" and prove, by linguistic means exclusively, that any hypothesis of the form "I am dreaming" is meaningless (!), is to be regarded as a characteristic product of the school: It should not be possible, psychologically to experience higher order dreams, namely dreaming about dreams, yet such experiences are among the staple phenomena of empirical depth psychology.

Our critical observations, concerning "linguistic positivism", will be brief. This school of thought has not overcome, but has rather preserved, the inherent defects of "logical positivism"; in addition, it has introduced a set of theses of which the empirical and logical bases remain highly suspect. Especially are noteworthy the theses to the effect that: (a) Language constitutes the substance of thought rather than merely a means for expression thereof; (b) The function of philosophy, accordingly, consists of the study of language rather than the study of ideas. "In other words," writes A. J. Ayer (1946), "the propositions of philosophy are not factual, but linguistic in character." It may be observed that linguistic positivism tends to use the term "language" loosely. If the adjective "linguistic" here means that the propositions of philosophy have *no* reference, then they are, together with propositions of logic and mathematics, altogether void of meaning, if, however, these "linguistic propositions" always *have* a reference, without this reference being necessarily factual, then it is not correct to describe the propositions of philosophy as merely "linguistic". The dichotomy of "fact" and "language" has replaced the dichotomy of "facts" and "ideas", in this context, precisely because of the linguistic interpretation of the science of logic itself. We shall not repeat here our critique of the linguistic interpretation of logical forms (cf. Chapter 2: I). Suffice it to point out that this interpretation is based upon a psychological assumption concerning the relationship between thought and language, namely the arbitrary identification of the two processes, which we have already demonstrated to be untenable in the light of modern psychology (cf. Chapter 6: I). In other words, psychological investigation overwhelmingly supports the contrary hypothesis that thought processes are genetically and functionally independent of verbal behavior. Philosophical studies cannot afford to proceed as if psychological research were entirely irrelevant.

From a purely logical point of view, the deprivation of symbols of their reference results in the elimination of their meaning (denotation as well as connotation). For, roughly speaking, if a symbol has no reference, then it has no theoretical significance whatever; and if a symbol has a reference, then its significance lies, not in itself, but in the reference beyond it. The *linguistic fallacy*, then, may be described as follows: That there are no entities, concrete or abstract, behind words; and that, consequently, words do not stand for anything; but that, yet, words can be significantly used. To limit the class of the objective reference of language to the class of "facts", precluding "ideas", is a limited form of the"linguistic fallacy". Philosophers who have taken philosophy seriously (as the highest kind of knowledge and not merely as a professional engagement) have always avoided the "linguistic fallacy" by maintaining a "picture theory" of language. According to this theory, language is the symbolic picture of reality; reality, in this context, consists of the data of perception (proprioceptive and exteroceptive) and of thought processes; and the relationship between the linguistic representation and the object represented is described by logical isomorphism. Accordingly, "words" correspond to elementary entities and relations, concrete and abstract, and "propositions" correspond to complex configurations. From Plato to Heidegger and from Aristotle to Wittgenstein, despite the diversity of their thoughts in other respects, the picture theory has been retained. Plato's conception of the "dialectic" as the science of ideas, James's hypothesis that the "stream of thought" continues in the absence of language, and Whitehead's observation to the effect that language is the tool of thought, illustrate the historical authenticity of the picture theory. Frege (97), maintaining that every word must *stand for* something, otherwise it "cometh of evil", continues the Platonic hypothesis to the effect that language is the garment of thought. (We must be wary of the fact that, as Wittgenstein has observed, the garment often hides the body rather than reveals it, but then the fault lies with language rather than with the thought.) The clearest statement of the picture theory has been given by Wittgenstein (369: 4.016): "In order to understand the essence of the proposition, consider hieroglyphic writing, which pictures the facts it describes." More recently, the original hypotheses of James and Whitehead have found corroboration in the writings of H. H. Price (291), who has observed that the thought process "overflows" its symbolic elements, and of Jørgen Jørgensen (303), who has arrived at the result that language is a necessary instrument of thought but subject to alteration. And we must use language, not as the tribune of verification, but as a conventional index of authentic experience. Spiegelberg has remarked: "To me language serves only as a hook, if not as a crook, to haul in this experience." We may add: When, however, experience is too profound or too subtle to be hauled in by language, then we must leave linguistic analysis aside, and resort to the logical analysis *of the thought of* experience.

The redeeming aspiration of linguistic positivism appears to be the construction of an "ideal language" as the universal language of philosophy. But the necessary condition for the construction of any "ideal language" consists of the prior establishment of a "logical schema" after which the ideal language may be patterned. Hence the logical dilemma of linguistic positivism: While every "ideal language" necessarily possesses a logical structure, yet, *in* a physical language there is no logical space for the *logical ideal.* And even if there were, the nature of the logical schema, corresponding to the nature of reality, would still remain an open question. Thus, in the final analysis, the controversy over language precipitates into the deeper controversy concerning the nature of our logical frame of reference.

Linguistic positivism, however, appears to neglect both the logical form and the representative function of language. The inevitable result is the fall of this method of philosophizing from the level of the dialectic of ideas to the level of word-games: It is no longer concerned with the objective *reference* of words but rather with the variations in the *usage* of words. It is consistently overlooked that usage itself, if it is to possess any significance, must have had an original reference. In the absence of ideas, words begin to parade as independent and self-sufficient entities. Philosophy then becomes a kind of "linguistic anthropology"; and philosophical thinking becomes an external activity involving perhaps even statistical methods (hence the vulgarized "doing philosophy"). In the light of the preceding observations, it is clear that, whatever we may be doing, if we engage in "doing" philosophy, in any sense of that plebeian term, then philosophy, as the highest discipline known to man, will also be "done for" and thereby "done with"! Relative to this, Albert Hofstadter (136) of Columbia University has observed that the grave error lies in mistaking the method of philosophy for the subject-matter of philosophy. Further, it may be remarked, the grave error lies in mistaking a single method (linguistic analysis) for the collective methodology of philosophy (including logical analysis and phenomenological analysis). The case of the linguistic positivist is ironic: His original logophobia has been transformed, by a sustained reaction-formation, into a linguistic religion. Indeed, linguistic positivism also poses as the spiritual healer for the philosophical perplexities of modern man: It calls itself, in a somewhat flattering fashion, "therapeutic positivism"; and assures us that linguistic analysis will render the philosophical patient immune to the contagion of metaphysical contemplation. However, in view of the apathy toward abstract thinking that this doctrine engenders in its disciples, it may be more correctly described as "linguistic chloroform" rather than as "linguistic antiseptic". For, instead of really eliminating metaphysical problems, it simply renders its followers insensitive to them. Those who want this kind of intellectual therapy may have it; it will give them intellectual euphoria. And with this observation we shall leave linguistic positivism at the level at which it remains.

The logical conclusion of our critical observations is that: In a profound sense positivism means negativism. Its ontological claim relative to what there *is*, and what can be known, shrinks by comparison with its ontological claim relative to what there is *not*, and what cannot be shown. The theoretic glory of the positivist analysis consists of the application of a physical paradigm to a nonphysical theory (e.g. psychological theory) resulting in the "elimination" of the latter. However, the simple "reductive fallacy" lies coiled benealth all such analyses, and infests the positivist straw-man of "unified science". It is not the author's proper task here to take stock of the paradoxes of positivism; nor is it the place to hold to task positivism for its habitual indulgence, like dialectical materialism, in the method of *Machtspruch*, a method of discourse which is alien to the philosophical tradition of realism. It is rather, before leaving this matter, to note its illusory outcome: Namely that, after systematic criticism has laid threadbare the logical limitations of neopositivism, there should be those who, juggling their way through endless contortions of linguistic dogmata, concealed by bracketing and parenthesizing, come out trumpeting to the effect that metaphsyics has been *eliminated.* If realistic philosophy is to have its renaissance, it must first renounce the finality of arbitrary grammarizing, realizing the limitations of language and the superficiality of ordinary usage, and get down to the investigation of the phenomenology of the things themselves, that is, the realistic assessment of the ontogeny and morphology of the objects of experience.

Conclusion

The author has endeavoured to outline a restatement of the great argument for a realistic interpretation of natural sciences (specifically psychology and biology). In the course of the present treatise we have referred, within the limits of our circumscribed subject, to the investigations of those epistemologists and psychologists which have proved germane to the realistic reconstruction of the philosophy of science. It is highly significant that our theoretical results, based upon an essentially different kind of evidence, should display a partial parallelism and complementarity with the contemporary phenomenalistic analyses in the philosophy of science, to which references have been made. In any case, the proper understanding of the modern problems of the psychological and biological sciences indicates a deep need for a reexamination and reconstruction of the philosophy of science. It is to be hoped that the present prolegomenon, albeit being based upon the science of psychology (and specifically upon two complementary trends), should prove germane to the philosophical problems of the family of biological sciences in general.

Our study has been confined, partly to the comparative analysis of two complementary trends in empirical psychology, and partly to the elucidation of their epistemological consequences for the philosophy of science. In this twofold way we have been able to trace, empirically as well as logically, the theoretical relationship between psychology, as a natural science, and philosophy proper. Thus, from the standpoint of phenomenological realism, psychology is bound up with philosophy by a double relationship: (α) The *transcendental relationship* of the two realms represented by the logical boundary which encloses the empirical contents of the one and is enclosed by the transempirical categories of the other. (β) The *concentric relationship* of the two realms represented by the epistemological coincidence of their respective subject-matters, that is, of the "objects" of consciousness with the "contents" of consciousness. Being concerned with the former relationship, we have neither sought, nor the scope of this treatise would have permitted, to examine the latter. It is in the work of Cassirer (60) that the reader must seek the profoundest analysis of this secondary relationship: "If we wish to see reality itself, free from all refracting media, we must submit to the guidance of inner instead of outward experience... This question brings us to the point where metaphysics and psychology meet and seem to fuse indissolubly." But this author, having examined the *philosophy of* psychology, that is, its methodological and epistemological foundations, from a logical point of view, of necessity must leave untouched the metaphysical horizon thereof. Indeed, *Wovon man nicht reden kann darüber muss man schweigen* (as Wittgenstein used to say), is true, given the prescribed context of our investigation.

A retrospective observation, which is not without proactive significance, must be recorded at the end of this protracted research: In the beginning, approaching our investigation but with a rudimentary framework, viewing the phenomena of empirical psychology through the concept of "epistemological spectrum", we were subsequently led by our prolonged study to the assumption of the general perspective of *phenomenological realism.* This philosophical transformation was accelerated, as a synthetic solution, by the one-sidedness of contemporary schools. And it was concluded that only this polylevel perspective, of which the roots go deep into the empirical as well as the rational grounds, was potentially able to provide a logical space for all the phenomena of experience. Indeed, it is already becoming apparent that realistic philosophy, which attains a higher level of objectivity by approaching the "ideal of philosophy" described by Whitehead (365), sees proportionately farther into the horizon of reality. We shall refrain from asking here: What is the nature of reality proper and the forms thereof, as conceived by realistic philosophy, and what are the essential traits that distinguish this perspective from those of other contemporary philosophies? With this general problem, which is primarily ontological and secondarily epistemological, marking the transition from the philosophy of science into speculative philosophy (metaphysics), this author brings the present treatise to its proper termination, leaving the greater task of the philosophical study of the nature of reality for a work of greater scope in the future.

GENERAL BIBLIOGRAPHY

Note: The dates given for the sources are the dates of their latest editions. (In special cases the date of the first edition is given in parenthesis).

(1) Abel, Th. "The Operation Called *Verstehen*," in *Readings in the Philosophy of Science* (eds. H. Feigl & M. Brodbeck). Appleton-Century-Crofts Inc., New York, 1953.

(2) Adams, J. "The Status of Psychology in the Universities of Austria and Germany (1955–56)," *J. General Psychology*, 56 (1957), 147–157.

(3) Adler, A. *The Practice and Theory of Individual Psychology*. Routledge & Kegan Paul Ltd., London, 1925.

(4) Aebli, H. Application à la didactique de la psychologie de Jean Piaget. Thèse de doctorat, Université de Genève, 1951.

(5) Ajuriaguerra, J. de. "L'état actuel de la théorie de la gestalt en psychoneurologie," *Revue suisse de la psychologie*, 13 (1954), 16–53.

(6) Alexander, F. "Fundamental Concepts of Psychosomatic Research," *Psychosomatic Medicine*, 5 (1943), 205–210.

(7) Allport, F. H. *Theories of Perception and the Concept of Structure*. Wiley Co., New York, 1955.

(8) Allport, G. W. "The Psychologist's Frame of Reference," *Psychological Bulletin*, 37 (1940), 1–28.

(9) Allport, G. W. *The Use of Personal Documents in Psychological Science*. Social Science Research Council, New York, 1942.

(10) Allport, G. W. "The Productive Paradoxes of William James," *Psychological Review*, 50 (1943), 95–120.

(11) Allport, G. W. *Becoming*. Yale University Press, 1955.

(12) Ames, L. B. "The Development of the Sense of Time in the Child," *J. Genetic Psychology*, 68 (1946), 97–125.

(13) Ames, L. B. *Child Rorschach Responses*. Harper Co., New York, 1952.

(14) Anastasi, Anne. *Differential Psychology*. Macmillan Co., New York, 1958.

(15) Anastasi, A. & Foley, J. "Survey of the Literature on Artistic Behavior in the Abnormal." *Psychological Monographs*, 1940, No. 237.

(16) Angell, J. R. "The Province of Functional Psychology," *Psychological Review*, 14 (1907), 61–91.

(17) Apostel, L. "Logique et apprentissage," *Études d'épistémologie génétique*, 8 (1959), 1–138.

(18) Archer, E. J. "Identification of Visual Patterns as a Function of Information Load," *J. Experimental Psychology*, 48 (1954), 313–317.

(19) Arnheim, R. "The Gestalt Theory of Expression," *Psychological Review*, 56 (1949), 156–171.

(20) Asch, S. E. "Forming Impressions of Personality," *J. Abnormal & Social Psychology*, 41 (1946), 258–290.

(21) Asch, S. E. *Social Psychology*. Prentice-Hall Co., Englewood Cliffs (N.J.), 1952.
(22) Asch, S. E. "Perceptual Conditions of Association," in *Documents of Gestalt Psychology* (ed. M. Henle). University of California Press, 1961.
(23) Baldwin, J. M. *Thoughts and Things*. Macmillan Co., New York, I–III (1906–11).
(24) Bash, K. W. *Consciousness and the Unconscious in Depth and Gestalt Psychology*. North Holland Publishing Co., Amsterdam, 1949.
(25) Bartlett, F. C. *Thinking (An Experimental and Social Study)*. Basic Books Inc., New York, 1958.
(26) Bayley, Nancy. "Consistency and Variability in the Growth of Intelligence," *J. Genetic Psychology*, 75 (1949), 165–196.
(27) Bayley, Nancy. "The Growth of Intelligence," *American Psychologist*, 10 (1955), 805–818.
(28) Beardslee, D. & Wertheimer, M. (eds.) *Readings in Perception*. Van Nostrand Co., Princeton (N.J.), 1958.
(29) Beizmann, Cécile. "Étude génétique de la projection enfantine," in *Actes du XVe Congrès International de Psychologie (1957)*. North Holland Publishing Co., Amsterdam, 1959.
(30) Bellak, L. (ed.) *Contemporary European Psychiatry*. Grove Press, New York, 1961.
(31) Benjamin, A. C. *Operationism*. Thomas Co., Springfield (Illinois), 1955.
(32) Bergius, R. "Entwicklung als Stufenfolge," in *Entwicklungspsychologie* (Hg. H. Thomae). Verlag für Psychologie, Göttingen, 1959.
(33) Bergius, R. "Die Bedeutung der objektiven und phänomenalen Strukturiertheit für das Lernen," *Berichte der XXII Kongress des Deutsches Gesellschaft für Psychologie*. Göttingen (1960).
(34) Bergmann, G. "Configurations and Reduction," in *Philosophy of Science* (Ch. 3). University of Wisconsin Press, 1957.
(35) Bergmann, G. & Spence, K. "The Logic of Psychophysical Measurement," *Psychological Review*, 51 (1944), 1–24.
(36) Berlyne, D. & Piaget, J. "Théorie du comportement et opérations," *Études d'épistémologie génétique*, 12 (1960).
(37) Bohr, Niels. "Causality and Complementarity," *Philosophy of Science*, 4 (1937), 289–298.
(38) Boring, E. G. "A Psychological Function is the Relation of Successive Differentiations of Events in the Organism," *Psychological Review*, 44 (1937), 445–461.
(39) Boring, E. G. *A History of Experimental Psychology*. Appleton-Century-Crofts Inc., New York, 1950 (1929).
(40) Boring, E. G. *Sensation and Perception in the History of Experimental Psychology*. Appleton-Century-Crofts Inc., New York, 1942.
(41) Boring, E. G. "A History of Introspection," *Psychological Bulletin*, 50 (1953), 169–189.
(42) Bragg, A. "Notes on the Psychology of Frogs and Toads," *J. General Psychology*, 32 (1945), 27–37.
(43) Braine, M. D. Ontogeny of Certain Logical Operations. *Psychological Monographs*, 1959, No. 475.
(44) Brengelmann, J. "Der Aufbau des Gedächtnisses nach Allgemeinheitsgraden," *Zeitschrift für experimentelle & angewandte Psychologie*, 1 (1953), 65–101.
(45) Brogden, W. J. "Animal Studies of Learning," in *H. Experimental Psychology* (ed. S. Stevens). Wiley Co., New York, 1951.
(46) Brower, D. "The Problem of Quantification in Psychological Science," *Psychological Review*, 56 (1949), 325–333.

(47) Bruner, J. S. "Perceptual Readiness," *Psychological Review*, 64 (1957), 123–152.
(48) Bruner, J. S. & Coworkers. *A Study of Thinking*. Wiley Co., New York, 1956.
(49) Brunswik, Egon. *Conceptual Framework of Psychology*. University of Chicago Press, 1952.
(50) Bunge, Mario. "Levels: A Semantical Preliminary," *Review of Metaphysics*, 13 (1960), 396–406.
(51) Buytendijk, F. J. J. *Traité de psychologie animale*. Presses Universitaires de France, Paris, 1952.
(52) Buytendijk, F. J. J. *Die Frau (Natur, Erscheinung, Dasein)*. J. P. Bachem Verlag, Köln, 1953.
(53) Buytendijk, F. J.J. *Allgemeine Theorie der menschlichen Haltung und Bewegung*. Springer Verlag, Heidelberg, 1956.
(54) Buytendijk, F. J. J. "The Function of the Parts within the Structure of the Whole," *J. Individual Psychology*, 15 (1959), 73–78.
(55) Buytendijk, F. J. J. *Pain (Modes and Functions)*. University of Chicago Press, 1962.
(56) Cameron, N. "The Development of Paranoic Thinking," *Psychological Review*, 50 (1943), 219–233.
(57) Carmichael, L. "The Development of Behavior in Vertebrates Experimentally Removed from the Influence of External Stimulation," *Psychological Review*, 33 (1926), 51–58.
(58) Carmichael, L. "Ontogenetic Development," in *H. Experimental Psychology* (ed. S. Stevens). Wiley Co., New York, 1951.
(59) Carnap, R. "Die physikalische Sprache als Universalsprache der Wissenschaft," *Erkenntnis*, 2 (1931), 432–465. Also: "Die Psychologie in physikalischer Sprache," *Erkenntnis*, 3 (1932–33), 107–142.
(60) Cassirer, E. *The Phenomenology of Knowledge* (vol. 3 of the *Philosophie der symbolischen Formen* (1929) trans. R. Manheim). Yale University Press, 1957. Also: *Zur Logik der Naturwissenschaften*, Göteborg University, 1942.
(61) Chessick, R. D. "The Application of Neurological Studies in an Approach to Some Philosophical Problems," *Philosophy of Science*, 20 (1953), 300–312.
(62) Claparède, Éd. "Point de vue physico-chimique et point de vue psychologique," *Scientia*, 1912.
(63) Claparède, Éd. "La psychologie fonctionnelle," *Acta Psychologica*, 1 (1936).
(64) Claparède, Éd. *Psychologie de l'enfant et pédagogie expérimentale*. Éditeurs: J. Piaget et P. Bovet. Institut J. J. Rousseau, Genève, 1946 (1926).
(65) Claparède, Éd. "La genèse de l'hypothèse," *Archives de psychologie*, 24 (1933–34), 1–155.
Cf. J. Piaget: "La psychologie d'Édouard Claparède," *Archives de psychologie*, 28 (1940–41).
(66) Conrad, K. "Begriff der Vorgestalt," *Nervenarzt*, 21 (1950), 58–63.
(67) *Contemporary Approaches to Cognition* (University of Colorado Symposium). Harvard University Press, 1957.
(68) Darwin Centennial (University of Chicago): *Evolution After Darwin*. University of Chicago Press, I–III (1960).
(69) Dennis, W. "Does Culture Appreciably Affect Patterns of Infant Behavior?", *J. Social Psychology*, 12 (1940), 305–317.
(70) Dennis, W. (ed.) *Readings in the History of Psychology*. Appleton-Century-Crofts Inc., New York, 1948.
(71) Deutsche, Jean. *The Development of Children's Concepts of Causal Relations*. University of Minnesota Press, 1937.
(72) Dewey, J. *How we Think*. D.C. Heath Co., New York, 1933.

(73) Dobzhansky, Th. *Genetics and the Origin of Species*. Columbia University Press, 1951.
(74) Dobzhansky, Th. "What is an Adaptive Trait?", *American Naturalist*, 90 (1956), 337–347.
(75) Dobzhansky, Th. "Human Mental Faculties and their Antecedents," in *Mankind Evolving* (Ch. 8). Yale University Press, 1962.
(76) Dunbar, Flanders. *Emotions and Bodily Changes* (A Survey of Literature on Psychosomatic Interrelationships 1910–1953). Columbia University Press, 1954.
(77) Duncker, K. "Behaviorismus und Gestaltpsychologie," *Erkenntnis*, 3 (1932–33), 162–176.
(78) Duncker, K. Problem Solving (Foreword by W. Köhler). *Psychological Monographs*, 1945, No. 270.
(79) Duncker, K. "Phenomenology and Epistemology of the Consciousness of Objects," *Philosophy & Phenomenological Research*, 7 (1946–47), 505–542.
(80) Eddington, A. *Philosophy of Physical Science*. Cambridge University Press & Macmillan Co., London, 1949.
(81) Ehrenfels, Ch. von. "Über Gestaltqualitäten," *Vierteljahrschrift für wissenschaftliche Philosophie*, 14 (1890), 249–292 (cf. *Psychological Review*, 44 (1937)).
(82) Ellis, W. D. (ed.) *Sourcebook of Gestalt Psychology*. Humanities Press, New York, 1950 (1938).
(83) Eng. Helga. *The Psychology of Children's Drawings*. Routledge & Kegan Paul Ltd., London, 1954.
(84) *Études d'épistémologie génétique* (Periodic publications of the researches of the Centre d'Épistémologie Génétique (Institut J.-J. Rousseau) at the Université de Genève). Éditeur: J. Piaget. Presses Universitaires de France, Paris, I–XII (1957–1960).
(85) Farber, M. *Foundations of Phenomenology*. Harvard University Press, 1943.
(86) Farber, M. (ed.) *Philosophic Thought in France and the United States*. University of Buffalo, 1950.
(87) Feigl, H. "The Mind-Body Problem in the Development of Logical Empiricism," *Revue internationale de philosophie*, 4 (1950), 64–83.
(88) Feigl, H. "Existential Hypotheses," *Philosophy of Science*, 17 (1950), 35–62.
(89) Feigl, H. "The 'Mental' and the 'Physical,'" in *Minnesota Studies in Philosophy of Science* (ed. H. Feigl, M. Scriven, G. Maxwell). University of Minnesota Press, II (1958).
(90) Feigl, H. "Philosophical Embarrassments of Psychology," *American Psychologist*, 14 (1959), 115–128.
(91) Ferdinand, W. "Experimentelle Untersuchungen über den Einfluss der persönlichen Wichtigkeit des Materials auf das Behalten," *Psychologische Forschung*, 25 (1959), 455–517.
(92) Feuer, L. S. "Dialectical Materialism and Soviet Science," *Philosophy of Science*, 16 (1949), 105–124.
(93) Flavell, J. H. *The Developmental Psychology of Jean Piaget*. Van Nostrand Co., New York, 1963.
(94) Fletcher, J. "Homeostasis as an Explanatory Principle in Psychology," *Psychological Review*, 49 (1942), 80–87.
(95) Florès, C. "Études sur les processus d'utilisation de la trace mnésique (le rappel, la reconnaissance, et le réapprentissage)," *Année psychologique*, 58 (1958), 25–43.
(96) Fraisse, P. *Psychologie du temps*. Presses Universitaires de France, Paris, 1957.
(97) Frege, G. *Philosophical Writings* (eds. P. Geach & M. Black). B. Blackwell, Oxford, 1952.

(98) Freud, Anna. "The Contribution of Psychoanalysis to Genetic Psychology," *American J. Orthopsychiatry*, 21 (1951), 476–497.

(99) Freud, S. *The Interpretation of Dreams*. Basic Books Inc., New York, 1955 (1900). Also: *Collected Papers* (ed. E. Jones). Basic Books Inc., New York, I–V (1959).

(100) Fuchs, R. "Emotionale und volitionale Reproduktionsfaktoren und die Gestalttheorie der Reproduktion," *Psychologische Beiträge*, 1 (1953), 389–425.

(101) Gelb, A. & Goldstein, K. "Analysis of a Case of Figural Blindness," in *Source-book of Gestalt Psychology* (ed. W. Ellis). Humanities Press, New York, 1950.

(102) Gesell, A. *The Embryology of Behavior*, Harper Bros., New York, 1945.

(103) Gibson, J. J. "A Critical Review of the Concept of Set in Contemporary Experimental Psychology," *Psychological Bulletin*, 38 (1941), 781–817.

(104) Gibson, J. J. *The Perception of the Visual World*. Houghton-Mifflin Co., Boston, 1950.

(105) Ginsberg, A. "Does Hullian Theory Provide the Adequate Foundations for a Comprehensive Theory of Human Behavior?", *J. General Psychology*, 51 (1954), 301–330.

(106) Ginsberg, A. "Hypothetical Constructs and Intervening Variables," *Psychological Review*, 61 (1954), 119–131.

(107) Gobar, A. Abstract Entities. Doctoral Thesis presented to a Special Committee of the Departments of Philosophy & Psychology at the University of Wisconsin (1959). Cf. "Abstract Entities in the Natural Sciences," *XIV Inter. Kongress f. Philosophie* (Wien) 1968.

(108) Gobar, A. "Emotions in the Light of Experimental Psychology," *Proceedings of the West Virginia Academy of Science*, 38 (Spring 1966).

(109) Gobar, A. "Les relations entre l'épistémologie et la psychologie," *Actes du VIIe Congrès Interaméricain de Philosophie* (1967), Presses de l'Université Laval, Canada.

(110) Goldstein, K. & Scheerer, M. Abstract and Concrete Behavior. *Psychological Monographs*, 1941, No. 239. Cf. K. Goldstein: *Human Nature in the Light of Psychopathology*. Harvard University Press, 1940.

(111) Goodenough, F. & Maurer, K. *The Mental Growth of Children*. University of Minnesota Press, 1942.

(112) Goodenough, F. & Tyler, L. *Developmental Psychology*. Appleton-Century-Crofts Inc., New York, 1959.

(113) Graumann, C. F. *Grundlagen einer Phänomenologie und Psychologie der Perspektivität*. W. de Gruyter Co., Berlin, 1960.

(114) Grelling, K. & Oppenheim, P. "Der Gestaltbegriff im Lichte der neuen Logik," *Erkenntnis*, 7 (1938), 211–224.

(115) Grene, Marjorie. "The Logic of Biology," in *The Logic of Personal Knowledge*. Routledge & Kegan Paul Ltd., London, 1961, pp. 191–205. Also: "Two Evolutionary Theories," *B. J. Phil. Sc.*, 9 (1958), 110–27 & 185–93.

(116) Grossmann, R. S. "Logischen Analyse des Neobehaviorismus," *Psychologische Rundschau*, 6 (1955), 245–260.

(117) Gurwitsch, A. *Théorie du champ de la conscience*. Desclée de Brouwer, Paris, 1957.

(118) Haartman, L. v. "Eine Methode zum vergleichenden Studium der optischen Wahrnehmungsfähigkeit höherer Tiere," *Behaviour*, 1 (1947), 35–55.

(119) Hadamard, J. "A propos de la psychologie de l'invention," *Acta Psychologica*, 8 (1951).

(120) *Handbuch der Psychologie* (12 Bänden): Specially *Allgemeine Psychologie: Der Aufbau des Erkennens* (Band I–II). Hg. von Ph. Lersch, F. Sander, H. Thomae. Verlag für Psychologie, Göttingen (1959–0000).

(121) Hanfmann, E. & Kasanin, J. Conceptual Thinking in Schizophrenia. *Nervous*

& Mental Diseases Monographs, 1942, No. 67.
(122) Harlow, H. F., "Thinking", in *Theoretical Foundations of Psychology* (ed. H. Helson). Van Nostrand Co., New York, 1951.
(123) Harlow, H. F. "The Evolution of Learning," in *Behavior and Evolution* (eds. A. Roe & G. Simpson). Yale University Press, 1958.
(124) Hartmann, G. W. "The Gestalt View of the Process of Institutional Transformation," *Psychological Review*, 53 (1946), 282–289.
(125) Hartmann, N. *Philosophie der Natur*. W. de Gruyter Co., Berlin, 1950.
(126) Haseloff, O. H. (Hg.) *Moderne Entwicklungspsychologie*. Berlin, 1956.
(127) Heberer, G. (Hg.) *Evolution der Organismen*. G. Fischer Verlag, Stuttgart, 1954.
(128) Heidbreder, E. The Attainment of Concepts: "Methodology," *J. Genetic Psychology*, 35 (1946), 173–189; "Problem," *J. Genetic Psychology*, 35 (1946), 191–223; "Process," *J. Psychology*, 24 (1947), 93–138.
(129) Heidegger, M. *Was heisst Denken?* Max Niemeyer Verlag, Tübingen, 1961.
(130) Heisenberg, W. *Philosophic Problems of Nuclear Science*. Pantheon Books Inc., New York, 1952.
(131) Helm, J. "Über den Einfluss affektiver Spannungen auf das Denkhandeln," *Zeitschrift für Psychologie*, 157 (1954).
(132) Henle, Mary (ed.) *Documents of Gestalt Psychology*. University of California Press, 1961.
(133) Hess, E. H. "Development of the Chick's Responses to Light and Shade Cues of Depth," *J. Comparative & Physiological Psychology*, 43 (1950), 112–122.
(134) Hess, E. H. "Imprinting," *Science*, 130 (1959), 133–141.
(135) Hochberg, J. "Effects of the Gestalt Revolution," *Psychological Review*, 64 (1957), 73–84.
(136) Hofstadter, A. "Ryle's Category Mistake," *J. Philosophy*, 48 (1951), 257–270.
(137) Hofstätter, P. R. "Die beiden Wissensbegriffe und die Psychologie," *Jb. Psychologie & Psychotherapie*, 2 (1954).
(138) Höhn, E. "Entwicklung als aktive Gestaltung," in *Entwicklungspsychologie* (Hg. H. Thomae). Verlag für Psychologie, Göttingen, 1959.
(139) Holzner, B. *Amerikanische und Deutsche Psychologie*. Holzner Verlag, Würzburg, 1958.
(140) Høffding, H. *Psychologie in Umrissen auf Grundlage der Erfahrung*. Leipzig, 1922. (Cf. the French edition with a "*Préface*" by Pierre Janet, Paris, 1909).
(141) Hull, C. L. "The Concept of the Habit-Family Hierarchy and Maze Learning," *Psychological Review*, 41 (1934), 35–54 & 134–152.
(142) Humphrey, G. *Thinking*. Wiley Co., New York, 1951.
(143) Husserl, E. *Phänomenologische Psychologie* (Hg. W. Biemel), M. Nijhoff, Den Haag, 1962.
(144) Inhelder, B. "Die affektive und kognitive Entwicklung des Kindes," *Schweizerische Zeitschrift für Psychologie*, 15 (1956).
(145) Inhelder, B. & Piaget, J. *The Growth of Logical Thinking*. Basic Books Inc. New York, 1958.
(Cf. C. Parsons: "Review," *B.J. Psychology*, 51 (1960), 75–84).
(146) James, Wm. *Principles of Psychology*. Dover Publications, New York, I–II, 1950 (1890).
(147) James, Wm. *Essays in Radical Empiricism & A Pluralistic Universe* (ed. R. B. Perry). Longmans & Green Co., New York, 1943 (1909 & 1912).
(148) Janet, Pierre. *Les débuts de l'intelligence*. Flammarion, Paris, 1935. Also: *L'intelligence avant le langage*. Flammarion, Paris, 1936.
(149) Jessor, R. "The Problem of Reductionism in Psychology," *Psychological Review*, 65 (1958), 170–178.
(150) Johansson, G. "Configurations in the Perception of Velocity," *Acta Psychologica*,

7 (1950), 25–79.
(151) Jørgensen, Jørgen. "Remarks Concerning the Concept of Mind and the Problem of Other People's Minds," *Theoria*, 15 (1949), 116–127.
(152) Jung, C. G. *Psychological Types*. Harcourt-Brace Co., New York, 1924.
(153) Kafka, G. "Die metaphysischen Voraussetzungen der Psychologie," in *Actes du Xe Congrès International de Philosophie (1948)*. North Holland Publishing Co., Amsterdam, 1949.
(154) Kaila, E. "Logik und Psychophysik: Ein Beitrag zur theoretischen Psychologie," *Theoria*, 10 (1944), 91–119.
(155) Kainz, F. "Das Denken und die Sprache," in *Allgemeine Psychologie* (Hg. R. Bergius). Verlag für Psychologie, Göttingen, 1964.
(156) Kanner, L. *Child Psychiatry*. Thomas Co., Springfield (Illinois) 1957.
(157) Kant, Immanuel, *Kritik der reinen Vernunft* (Hg. Preussischen Akademie der Wissenschaften). G. Reimer Verlag, Berlin, 1911 (1781 & 1787).
(158) Kantor, J. R. *Problems of Physiological Psychology*. Principia Press, Indiana, 1947.
(159) Kantor, J. R. *Psychology and Logic*. Principia Press, Indiana, I–II (1945–50).
(160) Karsten, Anitra. "Psychische Sättigung," *Psychologische Forschung*, 10 (1928), 142–254.
(161) Kasanin, J. S. (ed.) *Language and Thought in Schizophrenia*. University of California Press, 1944.
(162) Katz, D. *Gespräche mit Kindern*. Springer Verlag, Berlin, 1928.
(163) Katz, D. *The World of Colour*. Routledge & Kegan Paul Ltd., London, 1935.
(164) Klüver, Heinrich. An Experimental Study of the Eidetic Type. *Genetic Psychology Monographs*, 1926, No. 2.
(165) Klüver, Heinrich. *Behavior Mechanisms in Monkeys*. University of Chicago Press, 1957.
(166) Koffka, K. "Perception: An Introduction to the Gestalttheorie," *Psychological Bulletin*, 19 (1922), 531–585.
(167) Koffka, K. *Principles of Gestalt Psychology*. Routledge & Kegan Paul Ltd., London, 1935.
(168) Kohler, Ivo. *Über Aufbau und Wandlungen der Wahrnehmungswelt*. Rohrer Verlag, Wien, 1951.
(169) Köhler, Wolfgang, *The Mentality of the Apes*. Routledge & Kegan Paul Ltd., London, 1927.
(170) Köhler, Wolfgang. *The Place of Value in a World of Facts*. (The William James Lectures delivered at Harvard University). Liveright Co., New York, 1938.
(171) Köhler, Wolfgang. *Dynamics in Psychology*. Liveright Co., New York, 1940.
(172) Köhler, Wolfgang. "On the Nature of Associations," *Proceedings of the American Philosophical Society*, 84 (1941), 489–502.
(173) Köhler, Wolfgang. *Gestalt Psychology*. Liveright Co., New York, 1947.
(174) Köhler, Wolfgang. *Die physischen Gestalten in Ruhe und im stationären Zustand (Eine naturphilosophische Untersuchung)*, Erlangen, 1920 (Abstract 1950).
(175) Köhler, Wolfgang. "Psychology and Evolution," *Acta Psychologica*, 7 (1950), 288–297.
(176) Köhler, Wolfgang. "Psychologie und Naturwissenschaft," in *Proceedings of the XVth International Congress of Psychology (1957)*. North Holland Publishing Co., Amsterdam, 1959.
(177) Köhler, Wolfgang. "The Present Situation in Brain Physiology," *American Psychologist*, 13 (1958), 150–154.
(178) Köhler, W. & Coworkers. "An Investigation of Cortical Currents," *Proceedings of the American Philosophical Society*, 96 (1952), 290–330.

(179) Köhler, W. & Coworkers. "Currents of the Auditory Cortex in the Cat," *J. Cellular & Comparative Physiology*, 45 (1955), Supplement I.
(180) Köhler, W. & Dinnerstein, D. "Figural Aftereffects in Kinesthesis," *Miscellanea Psychologica*, Institut Superieur de Philosophie, Louvain, 1947.
(181) Köhler, W. & Emery, D. "Figural Aftereffects in the Third Dimension of Visual Space," *American J. Psychology*, 60 (1947), 159–201.
(182) Köhler, W. & Fishback, J. "The Destruction of the Mueller-Lyer Illusion," *J. Experimental Psychology*, 40 (1950), 267–281 & 398–410.
(183) Köhler, W. & Held, R. "The Cortical Correlate of Pattern Vision," *Science*, 110 (1949), 414–419.
(184) Köhler, W. & O'Connell, D. "Currents of the Visual Cortex in the Cat," *J. Cellular & Comparative Physiology*, 49 (1957), Supp. II.
(185) Köhler, W. & Wallach, H. "Figural Aftereffects," *Proceedings of the American Philosophical Society*, 88 (1944), 269–357.
(186) Köhler, W. & Wegener, J. "Currents of the Human Auditory Cortex," *J. Cellular & Comparative Physiology*, 45 (1955), Supp. I.
(187) Krechevsky, I. The Genesis of Hypotheses in Rats. University of California Publications in Psychology, VI (1932), No. 4. Also: "Hypotheses in Rats," *Psychological Review*, 39 (1932), 516–532.
(188) Kretschmer, E. *Körperbau und Charakter*. Springer Verlag, Heidelberg, 1955. Also: "Der Typus als erkenntnistheoretisches Problem," *Studium Generale*, 4 (1951), 399–401.
(189) Krueger, F. *Zur Philosophie und Psychologie der Ganzheit* (Schriften (1918–1940) hg. E. Heuss). Springer Verlag, Heidelberg, 1953.
(190) Lashley, K. S. *Brain Mechanisms and Intelligence*. University of Chicago Press, 1929.
(191) Lashley, K. S. "Coalescence of Neurology and Psychology," *Proceedings of the American Philosophical Society*, 84 (1941), 461–470.
(192) Lashley, K. S. "Structural Variation in the Nervous System in Relation to Behavior," *Psychological Review*, 54 (1947), 325–334.
(193) Lashley, K. S. & Wade, M. "The Pavlovian Theory of Generalization," *Psychological Review*, 53 (1946), 72–87.
(194) Langeveld, M. J. "Principiele gesichtspunten met betrekking tot Piagets kinderpsychologie," *Vlaamsch Opvoedkundig Tijdschrift*, 28 (1947), 65–76.
(195) Langeveld, M. J. "Die Bedeutung des eigenen Körpers für das Selbsterlebnis des Kindes," *Psychologische Rundschau*, 5 (1954), 206–220.
(196) Langeveld, M. J. *Studien zur Anthropologie des Kindes*. Max Niemeyer Verlag, Tübingen, 1956.
(197) Langeveld, M. J. "Die Projektion im kindlichen Seelenleben," *Psychologische Rundschau*, 8 (1957), 243–254.
(198) Lewin, K. "Defining the 'Field' at a Given Time," *Psychological Review*, 50 (1943), 292–310.
(199) Lichtenstein, P. E. "Psychology as a Genetic Science," *J. General Psychology*, 42 (1950), 313–332.
(200) Lindsay, R. B. "A Critique of Operationalism in Physics," *Philosophy of Science*, 4 (1937), 456–470.
(201) Linschoten, J. *Strukturanalyse der binokularen Tiefenwahrnehmung*. Groningen, 1956.
(202) Linschoten, J. *Auf dem Weg zu einer phänomenologischen Psychologie: Die Psychologie von William James*. W. de Gruyter Co., Berlin, 1961.
(203) London, I. D. "The Concept of the Behavioral Spectrum," *J. Genetic Psychology*, 74 (1949), 177–184.
(204) London, I. D. "Quantum Biology and Psychology," *J. Genetic Psychology*, 81

(1952), 123–149.
(205) Lorenz, K. "Über die Bildung des Instinktbegriffs," *Naturwissenschaften*, 25 (1937), 289ff.
(206) Lorenz, K. "Die angeborenen Formen möglicher Erfahrung," *Zeitschrift für Tierpsychologie*, 5 (1963), 235–409.
(207) Luchins, A. S. Mechanization in Problem Solving. *Psychological Monographs*, 1942, No. 248.
(208) Luchins, A. S. "An Evaluation of Some Current Criticisms of Gestalt Psychological Work on Perception," *Psychological Review*, 58 (1951), 69–95.
(209) Macrae, D. "A Test of Piaget's Theories of Moral Development," *J. Abnormal & Social Psychology*, 49 (1954), 14–18.
(210) Madden, E. H. "The Philosophy of Science in Gestalt Theory," *Philosophy of Science*, 19 (1952), 228–238.
(211) Maier, N. R. F. "Reasoning in White Rats," *Comparative Psychology Monographs*, 1929, No. 6.
(212) Maier, N. R. F. "Reasoning in Children," *J. Comparative Psychology*, 21 (1936), 257–366.
(213) Maier, N. R. F. Reasoning in Humans: "Direction," *J. Comparative Psychology*, 10 (1930), 115–143; "Solution," *J. Comparative Psychology*, 12 (1931), 181–195; "Mechanisms," *J. Experimental Psychology*, 35 (1945), 349–360.
(214) Mandler, G. "From Association to Structure," *Psychological Review*, 69 (1962), 415–427.
(215) Mays, W. "The Epistemology of Professor Piaget," *Proceedings of the Aristotelian Society*, 1954–55. Also: "Can Machines Think?", *Philosophy*, 1952.
(216) Margenau, H. "The Methodology of Modern Physics," *Philosophy of Science*, 2 (1935), 48–72 & 164–187.
(217) Margenau, H. "Critical Points in Modern Physical Theory," *Philosophy of Science*, 4 (1937), 337–370.
(218) Margenau, H. "Phenomenology and Physics," *Philosophy & Phenomenological Research*, 5 (1944–45), 269–280.
(219) Margenau, H. *The Nature of Physical Reality*. McGraw-Hill Co., New York, 1950.
(220) Margenau, H. "Can Time Flow Backwards?", Philosophy of Science, 21 (1954), 79–92.
(221) Maslow, A. H. *Toward a Psychology of Being*. Van Nostrand Co., Princeton (N.J.), 1962.
(222) Meili, R. "Les perceptions des enfants et la psychologie de la gestalt," *Archives de psychologie*, 23 (1931).
(223) Meili, R. "Gestaltprozess und psychische Organisation," *Schweizerische Zsch. f. Psychologie*, 12 (1953).
(224) Metzger, Wg. *Gesetze des Sehens*. W. Kramer Verlag, Frankfurt a.M., 1953.
(225) Metzger, Wg. *Psychologie: Die Entwicklung ihrer Grundannahmen seit der Einführung des Experiments*. Darmstadt, 1954.
(226) Metzger, Wg. "Die Entwicklung der Erkenntnisprozesse," in *Entwicklungspsychologie* (Hg. H. Thomae). Verlag für Psychologie, Göttingen, 1959.
(227) Michotte, A. *La perception de la causalité*. Publications Universitaires de Louvain (Belgique), 1954.
(228) Mintz, A. "Recent Developments in Psychology in U.S.S.R.," *Annual Review of Psychology*, IX–X (1958–59).
(229) Morf, A. "Les relations entre la logique et le langage lors du passage du raisonnement concret au raisonnement formel," *Études d'épistémologie génétique*, 3 (1957), 173–204.
(230) Morgan, C. T. (& E. Stellar). *Physiological Psychology*. McGraw-Hill Co.,

New York, 1950.
(231) Müller, G. E. "Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes," in *Zsch.f. Psychologie* (Ergbd. 5/8/9): I(1911), III(1913), II(1917). Also: *Komplextheorie und Gestalttheorie*, Göttingen, 1923.
(232) Nagel, E. "Malicious Philosophies of Science," in *Sovereign Reason*. Free Press, New York, 1954.
(233) Nagel, E. "Methodological Issues in Psychoanalytic Theory," in *Psychoanalysis and Philosophy* (Symposium of the Institute of Philosophy in New York University ed. by S. Hook). New York University Press, Washington Square, 1959.
(234) Nagel, E. *The Structure of Science*. Harcourt-Brace Co., New York, 1961.
(235) Nagy, Maria. "The Child's Theories Concerning Death," *J. Genetic Psychology*, 73 (1948), 3–27.
(236) Nagy, Maria. "Children's Conceptions of Some Bodily Functions," *J. Genetic Psychology*, 83 (1953), 199–216.
(237) Nissen, H. W. "Phylogenetic Comparison," in *H. Experimental Psychology* (ed. S. Stevens). Wiley Co., New York, 1951.
(238) Novikoff, A. B. "The Concept of Integrative Levels in Biology," *Science*, 101 (1945), 209–215.
(239) Noelting, G. Structuration progressive de la figure de Mueller-Lyer. Thèse de doctorat, Université de Genève, 1960.
(240) Noelting, G. & Inhelder, B. "Passage d'un stade au suivant dans le développement des fonctions cognitives," in *Actes du XVe Congrès International de Psychologie (1957)*. North Holland Publishing Co., Amsterdam, 1959.
(241) Nordenskiold, E. *The History of Biology* (especially Pts. II–IV (1625–1925)). Trans, by L. B. Eyre. A. Knopf Inc., New York, 1928.
(242) Oléron, Pierre. Recherches sur le développement mental des sourds-muets. Thèse de doctorat, Université de Paris, 1957.
(243) Oppenheimer, E. "Optische Versuche über Ruhe und Bewegung," *Psychologische Forschung*, 20 (1935), 1–46.
(244) Oppenheimer, J. R. "Analogy in Science," *American Psychologist*, 11 (1956), 127–135.
(245) Osgood. C. E. *Method and Theory in Experimental Psychology*. Oxford University Press, 1953.
(246) Pap, Arthur. "Does Science have Metaphysical Presuppositions?", *Elements of Analytic Philosophy*. Macmillan Co., New York, 1949.
(247) Patrick, Catherine, "Creative Thought in Poets," *Archives of Psychology*, 1935, No. 178.
(248) Patrick, Catherine. "Creative Thought in Artists," *J. Psychology*, 4 (1937), 35–73.
(249) Pavlov, I. P. *Experimental Psychology & Other Essays*. Philosophical Library, New York, 1957.
(250) Penfield, W. "The Permanent Record of the Stream of Consciousness," in *Proceedings of the XIVth International Congress of Psychology (1954)*. North Holland Publishing Co., Amsterdam, 1955.
(251) Perkins, M. "Intersubjectivity and Gestalt Psychology," *Philosophy and Phenomenological Research*, 13 (1952–1953), 437–451.
(252) Perls, F., Hefferline, R., Goodman, P. *Gestalt Therapy*. Julian Press, New York, 1951.
(253) Persons, S. (ed.) *Evolutionary Thought in America*. Yale University Press, 1950.
(254) Piaget, Jean. *Language and Thought of the Child*. Harcourt-Brace Co., New York, 1926.
(255) Piaget, Jean. *Judgment and Reasoning in the Child*. Routledge & Kegan Paul

Ltd., London, 1928.

(256) Piaget, Jean. *The Child's Conception of the World.* Routledge & Kegan Paul Ltd., London, 1929.

(257) Piaget, Jean. *The Child's Conception of Physical Causality.* Routledge & Kegan Paul Ltd., London, 1930.

(258) Piaget, Jean. *The Moral Judgment of the Child.* Routledge & Kegan Paul Ltd., London, 1932.

(259) Piaget, Jean. "Le méchanisme du développement mental et les lois du groupement des opérations," *Archives de psychologie,* 28 (1940–1941), 215–285.

(260) Piaget, Jean. *Développement de la notion de temps chez l'enfant.* Presses Universitaires de France, Paris, 1946.

(261) Piaget, Jean. *Les notions de mouvement et de vitesse chez l'enfant.* Presses Universitaires de France, Paris, 1946.

(262) Piaget, Jean. "L'analyse psychogénétique et l'épistémologie des sciences exactes," *Synthèse,* 7 (1948–1949), 32–49.

(263) Piaget, Jean. "Le problème neurologique et l'intériorisation des actions en opérations reversibles," *Archives de psychologie,* 32 (1949), 241–258.

(264) Pieaget, Jean. *Traité de logique.* Librairie Colin, Paris, 1949.

(265) Piaget, Jean. *Introduction à l'épistémologie génétique.* Presses Universitaires de France, Paris, I–III (1950).

(266) Piaget, Jean. *Psychology of Intelligence.* Routledge & Kegan Paul Ltd., London, 1950.

(267) Piaget, Jean. *The Child's Conception of Number.* Routledge & Kegan Paul Ltd., London, 1952.

(268) Piaget, Jean. *Essai sur les transformations des opérations logiques.* Presses Universitaires de France, Paris, 1952.

(269) Piaget, Jean. *Play, Dreams, and Imitation in Childhood.* Norton Co., New York, 1951.

(270) Piaget, Jean. *Logic and Psychology* ("Introduction" by Wolfe Mays). Manchester University Press, England, 1953.

(271) Piaget, Jean. *The Construction of Reality in the Child.* Basic Books Inc., New York, 1954.

(272) Piaget, Jean. "Ce que subsiste de la théorie de la gestalt dans la psychologie contemporaine de l'intelligence et de la perception," *Revue suisse de la psychologie,* 13 (1954), 72–83.

(273) Piaget, Jean. "Logique et équilibre dans les comportements du sujet," *Études d'épistémologie génétique,* 2 (1957), 27–117.

(274) Piaget, Jean (ed.) Les liaisons analytiques et synthétiques dans les comportements du sujet. *Études d'épistémologie génétique,* 4 (1957).

(275) Piaget, Jean. "Programme et méthodes de l'épistémologie génétique," *Études d'épistémologie génétique,* 1 (1957), 13–84.

(276) Piaget, Jean. "Assimilation et connaissance," *Études d'épistémologie génétique,* 5 (1958), 49–108.

(277) Piaget, Jean. "Apprentissage et connaissance," *Études d'épistémologie génétique,* 7 (1959) & 10 (1959).

(278) Piaget, Jean. "Le rôle de la notion d'équilibre dans l'explication en psychologie," in *Actes du XVe Congrès International de Psychologie* (1957). North Holland Publishing Co., Amsterdam, 1959.

(279) Piaget, J. & Coworkers. "Introduction à l'étude des perceptions chez l'enfant et analyse d'une illusion relative à la perception visuelle des circles concentriques," *Archives de psychologie,* 29 (1943), 1–111.

(280) Piaget, J. & Coworkers. *The Child's Conception of Geometry.* Basic Books Inc., New York, 1960.

(281) Piaget, J. & Inhelder, B. *Développement des quantités chez l'enfant: conservation et atomisme.* Delachaux et Niestlé, Suisse, 1941.

(282) Piaget, J. & Inhelder, B. *Genèse de l'idée de hasard chez l'enfant.* Presses Universitaires de France, Paris, 1951.

(283) Piaget, J. & Inhelder, B. *The Child's Conception of Space.* Routledge & Kegan Paul Ltd., London, 1956.

(284) Piaget, J. & Inhelder, B. *Genèse des structures logiques élémentaires.* Delachaux et Niestlé, Suisse, 1959.

(285) Piaget, J. & Morf, A. "Les isomorphismes partiels entre les structures logiques et les structures perceptives," *Études d'épistémologie génétique*, 6 (1958), 49–116.

(286) Piéron, H. *Sensations.* Yale University Press, 1952.

(287) Portmann, A. *Biologische Fragmente zu einer Lehre vom Menschen.* Schwabe Verlag, Basle, 1944.

(288) Pratt, C. C. *The Logic of Modern Psychology.* Macmillan Co., New York, 1939.

(289) Pratt, J. G. "The Homing Problem in Pigeons," *J. Parapsychology*, 17 (1953), 34–60.

(290) Prentice, W. "The Systematic Psychology of Wolfgang Köhler," in *Psychology* (ed. S. Koch). McGraw-Hill Co., New York, I (1959).

(291) Price, H. H. *Thinking and Experience.* Harvard University Press, 1953.

(292) Raaheim, K. "Problem Solving and the Awareness of the Missing Part," *Scandinavian J. Psychology*, 3 (1962), 129–131.

(293) Rapaport, D. (ed.) *Organization and Pathology of Thought.* Columbia University Press, 1951.

(294) Rashevsky, N. "Mathematical Biophysics and Psychology," *Psychometrika*, 1 (1936), 1–26.

(295) Reichenbach, H. *Philosophy of Space and Time.* Dover Publications, New York, 1958.

(296) Rensch, B. "Die phylogenetische Abwandlung der Ontogenese," in *Evolution der Organismen* (Hg. G. Heberer). G. Fischer Verlag, Stuttgart, 1954.

(297) Rensch, B. "Aesthetische Faktoren bei Farb und Formbevorzugungen von Affen," *Zeitschrift für Tierpsychologie*, 14 (1957), 71–99.

(298) Rensch, B. "Die Abhängigkeit der Struktur und der Leistungen tierischer Gehirne von ihrer Grösse," *Naturwissenschaften*, 45 (1958), 145–54 & 175–80.

(299) Rensch, B. *Homo Sapiens vom Tier zum Halbgott.* Vandenhoeck & Ruprecht Vg., Göttingen, 1959.

(300) Rensch, B. *Evolution above the Species Level* (Foreword by Th. Dobzhansky). Columbia University Press, 1959.

(301) Rescher, N. & Oppenheim, P. "The Logical Analysis of Gestalt Concepts", *B.J. Philosophy of Science*, 6 (1955), 89–109.

(302) Révész, G. "Tätigkeit des Psychologischen Laboratoriums der Universität Amsterdam," *Acta Psychologica*, 5 (1941) & 6 (1949).

(303) Révész, G. (ed.) *Thinking and Speaking.* North Holland Publishing Co., Amsterdam, 1954.

(304) Roe, A. & Simpson, G. (eds.) *Behavior and Evolution.* Yale University Press, 1958.

(305) Rohracher, H. "Scientific Work at the Psychological Department of the University of Vienna," *Acta Psychologica*, 8 (1951–52) & 13 (1957–58).

(306) Rommetveit, R. "Model Construction in Psychology: A Defence of Surplus Meanings of Psychological Concepts," *Acta Psychologica*, 11 (1955), 335–345.

(307) Rubin, E. "Visual Figures Apparenty Incompatible with Geometry," *Acta*

Psychologica, 7 (1950), 265–287.
(308) Russell, Bertrand. *Our Knowledge of the External World.* G. Allen & Unwin Ltd., London, 1926.
(309) Russell, D. H. *Children's Thinking.* Ginn Co., Boston, 1956.
(310) Saugstad, P. & Raaheim, K. "Problem Solving and Availability of Functions in Children," *Acta Psychologica*, 16 (1959), 45–58.
(311) "Scandinavian Psychology" (A symposium by J. Agrell, F. From, M. Takala, & E. Østlyngen), *Nordisk Psykologi*, 3 (1951).
(312) Scheglemann, L. "Eine 5-Komponententheorie des Farbensehens (Spektraltheorie)," *Proceedings of the XVth International Congress of Psychology (1957).* North Holland Publishing Co., Amsterdam, 1959.
(313) Schmidt, W. J. "Wie entstehen die Schillerfarben der Federn?", *Naturwissenschaften*, 39 (1952), 313–318.
(314) Schneider, F. "Realism in Recent German Philosophy," *Philosophy & Phenomenological Research*, 19 (1958–59), 143–182.
(315) Scriven, M. "A Study of Radical Behaviorism," in *Minnesota Studies in Philosophy of Science* (ed. H. Feigl & M. Scriven). University of Minnesota Press, I (1956).
(316) Sears, R. *Survey of Objective Studies of Psychoanalytic Concepts.* Social Science Research Council, New York, 1943.
(317) Sellars, R. W. "Gestalt and Relativity: An Analogy," *Philosophy of Science*, 23 (1956), 275–279.
(318) Sheldon, W. H. *Varieties of Human Physique.* Harper Bros., New York, 1940.
(319) Siegel, P. S. "Structure Effects within a Memory Series," *J. Experimental Psychology*, 33 (1943), 311–316.
(320) Simon, B. (ed.) *Psychology in the Soviet Union.* Stanford University Press and Routledge & Kegan Paul Ltd., London, 1957.
(321) Skinner, B. F. "Are Theories of Learning Necessary?", *Psychological Review*, 57 (1950), 193–216.
(322) Smedslund, J. "Epistemological Foundations of Behaviorism (A Critique)," *Acta Psychologica*, 11 (1955), 412–431.
(323) Spence, K. W. "Postulates and Methods of Behaviorism," *Psychological Review*, 55 (1948), 67–78.
(324) Spiegelberg, H. "Critical Phenomenological Realism," *Philosophy & Phenomenological Research*, 1 (1941), 154–176.
(325) Spiegelberg, H. "Toward a Phenomenology of Imaginative Understanding of Others," in *Proceedings of the XIth International Congress of Philosophy.* Brussels (1953).
(326) Spiegelberg, H. *The Phenomenological Movement.* M. Nijhoff, The Hague, I–II (1960).
(327) Spiegelberg, H. "Toward a Phenomenology of Experience," *American Philosophical Quarterly*, 1 (1964).
(328) Strasser, S. "Phenomenological Trends in European Psychology," *Philosophy & Phenomenological Research*, 18 (1957–58), 18–34.
(329) Strasser, S. *The Soul in Metaphysical and Empirical Psychology.* Duquesne University Press, 1961.
(330) Strasser, S. *Phenomenology and the Human Sciences.* Duquesne University Press, 1963.
(331) Strunz, S. "Zur Methodologie der psychologischen Typenforschung," *Studium Generale*, 4–5 (1951).
(332) Székely, L. "Knowledge and Thinking," *Acta Psychologica*, 7 (1950), 1–24.
(333) Teitelbaum, H. "An Analysis of the Disturbances of the Higher Cortical Functions (Agnosia, Apraxia, Aphasia)," *J. Nervous & Mental Diseases*, 97 (1943), 44–61.

(334) Terman, L. M. & Coworkers. *Genetic Studies of Genius.* Stanford University Press, I–V (1925–1959).
(335) Thomae, H. "Longitudinal Studies in Psychophysical Relationships," in *Proceedings of the XVth International Congress of Psychology (1957).* North Holland Publishing Co., Amsterdam, 1959.
(336) Thomae, H. (Hg.) *Entwicklungspsychologie,* Verlag für Psychologie, Göttingen, 1959.
(337) Thorndike, E. L. "James's Influence on the Psychology of Perception and Thought," *Psychological Review,* 50 (1943), 87–94.
(338) Tinbergen, N. "Die Übersprungbewegung," *Zeitschrift für Tierpsychologie,* 4 (1940), 1–40.
(339) Tinbergen, N. *The Study of Instinct.* Clarendon Press, Oxford, 1951.
(340) Titchener, E. B. "Prolegomena to a Study of Introspection," *American J. Psychology,* 23 (1912), 427–448.
(341) Tolman, E. C. "There is More than One Kind of Learning," *Psychological Review,* 56 (1949), 144–155.
(342) Tolman, E. C. *Behavior and Psychological Man.* University of California Press, 1951.
(343) Törnebohm, H. *A Logical Analysis of the Theory of Relativity* (especially Part II). Elanders Boktryckeri Aktiebolag, Göteborg, 1952.
(344) Van de Geer, J, P. A Psychological Study of Problem Solving. Doctoral Thesis, University of Leiden, 1957.
(345) Van Heerden, P. J. "What is Matter?", *Philosophy of Science,* 20 (1953), 276–285.
(346) Van Laer, P. H. (& H. J. Koren). *Philosophy of Science.* Duquesne University Press, I–II (1956–1962).
(347) Van Parreren, C. F. "A Viewpoint in Theory and Experimentation on Human Learning and Thinking," *Acta Psychologica,* 10 (1954), 351–380.
(348) Wallach, H. "Brightness Constancy and the Nature of Achromatic Colors," *J. Experimental Psychology,* 38 (1948), 310–324.
(349) Wallach, H. "The Perception of Motion," *Scientific American,* 201 (1959), 56–60.
(350) Wallach, H. "Some Considerations Concerning the Relation between Perception and Cognition," in *Documents of Gestalt Psychology* (ed. M. Henle). University of California Press, 1961.
(351) Wallon, Henri. *Les origines de la pensée chez l'enfant.* Presses Universitaires de France, Paris, I–II (1945).
(352) Watson, J. B. "Psychology as the Behaviorist Views It," *Psychological Review,* 20 (1913), 158–177.
(353) Weinberg, J. R. "Are There Ultimate Simples?" *Philosophy of Science,* 2 (1935), 389–399.
(354) Weiss, Paul. *Reality.* Princeton University Press, 1939. Also: "The Perception of Stars," *Review of Metaphysics,* 6 (1952–53), 233–238.
(355) Weizsäcker, V. v. *Der Gestaltkreis.* Stuttgart, 1947.
(356) Wellek, A. *Ganzheitspsychologie und Strukturtheorie.* Francke Verlag, Bern, 1955.
(357) Welch, L. "The Genetic Development of the Associational Structures of Abstract Thinking," *J. Genetic Psychology,* 56 (1940), 175–206.
(358) Welch, L. "An Integration of Some Fundamental Principles of Modern Behaviorism and Gestalt Psychology," *J. General Psychology,* 39 (1948), 175–190.
(359) Werner, H. *Comparative Psychology of Mental Development* (Foreword by G. W. Allport). International Universities Press, New York, 1957.
(360) Wertheimer, M. "Experimentelle Studien über das Sehen von Bewegung,"

Zeitschrift für Psychologie, 61 (1912), 161–278.
(361) Wertheimer, M. "Untersuchungen zur Lehre von der Gestalt (I–II," *Psychologische Forschung*, 1 & 4 (1921–1923), 47–58 & 301–350. (Cf. Ellis (ed.) *Sourcebook of G. Ps.* for abridged translation).
(362) Wertheimer, M. "On Truth" (1934), in *Documents of Gestalt Psychology* (ed. M. Henle). University of California Press, 1961.
(363) Wertheimer, M. "Discrimination Experiments (Two Logical Structures)," *Psychological Review*, 66 (1959), 252–266.
(364) Wertheimer, M. *Productive Thinking* (ed. Michael Wertheimer). Harper Bros., New York, 1959.
(365) Whitehead, A. N. *Process and Reality*. Humanities Press, New York, 1957 (1929).
(366) Wetter, G. *Dialectical Materialism*. Praeger Co., New York, 1960.
(367) Winthrop, H. "The Pythagorean Complex in the Behavioral Sciences," *J. Genetic Psychology*, 96 (1960), 301–319.
(368) Winthrop, Th. "The Theoretical Basis of *Biotypologie*," *Philosophy of Science*, 10 (1943), 131–139.
(369) Wittgenstein, L. *Tractatus Logicophilosophicus* (German Text & English Translation). Routledge & Kegan Paul Ltd., London, 1955 (1922).
(370) Woodworth, R. S. (& H. Schlosberg). *Experimental Psychology*. H. Holt Co., New York, 1954.
(371) Wulf, F. "Über die Veränderung von Vorstellungen (Gedächtnis und Gestalt)," *Psychologische Forschung*, 1 (1922), 333–373.
(372) Wundt, Wilhelm. *Grundzüge der physiologischen Psychologie*. Engelmann Verlag, Leipzig, I–III, 1908–1911 (1874). Also: "Über psychische Causalität und das Princip des psychophysischen Parellelismus," *Philosophische Studien* (Hg. W. Wundt), 10 (1894), 1–124.
(373) Yerkes, R. M. "Color Vision in the Ringdove," *Proceedings of the National Academy of Sciences*, 1 (1915), 117–119.
(374) Yerkes, R. M. & A. W. *The Great Apes: A Study of the Anthropoid Life*. Yale University Press, 1953.
(375) Zellinger, E. "Erkenntnistheoretische und methodologische Betrachtungen zur Psychologie als Wissenschaft," *Psychologische Rundschau*, 7 (1956), 124–147.

INDEX