III. STRUCTURE AND FUNCTION OF SCIENTIFIC CONCEPTS AND THEORIES

6. FUNDAMENTALS OF TAXONOMY

1. INTRODUCTION

THIS PAPER[1] attempts to provide a systematic background for a discussion of the taxonomy[2] of mental disorders. To this end, it analyzes the basic logical and methodological aspects of the classificatory procedures used in various branches of empirical science and indicates some implications which that analysis seems to suggest for the taxonomic problems of psychiatry.

2. CLASSES AND CONCEPTS

A classification, as is well known, divides a given set or class of objects into subclasses. The objects are called the *elements* or *members* of the given set; the set itself will also be referred to as the *universe of discourse*, especially when it is assumed to contain as its elements all the objects with which a given investigation is concerned.

The objects of a classification may be concrete things such as stars, crystals,

1. The following is the substance of a paper read at the Work Conference on Field Studies in the Mental Disorders held in New York in February, 1959, under the auspices of the American Psychopathological Association. The present text incorporates some changes I made in the original version as a result of the discussion of my paper. The papers read at the Conference, some of which I refer to by the names of their authors, were published in Zubin (1961), which also contains a record of the discussion.

2. The term 'taxonomy' often serves as a synonym for 'classification'; but I will here use the words 'taxonomy' and 'taxonomic' primarily to refer to the *theory* of classificatory procedures and systems. The two concepts thus distinguished are more fully characterized in the foreword of Gregg's study (1954), where "taxonomy proper" is contrasted with "methodological taxonomy".

rganisms, books, and so on; or they may be abstract entities such as numbers, inship systems, political ideologies, religions, or philosophical doctrines.

Each of the subclasses provided for in a given classification may be thought f as defined by the specification of necessary and sufficient conditions of membership in it, i.e., by stating certain characteristics which all and only the members f this class possess. Each subclass is thus defined by means of (more precisely, s the extension of) a certain *concept*, which represents the complex of characterstics essential for membership in that subclass. For example, in the division of positive integers into prime and composite numbers, the condition of membership in the former of these subclasses is that the number in question be greater han 1 and be an integral multiple only of 1 and of itself. These characteristics letermine the concept of prime number, and the corresponding class is the xtension of this concept.

Similarly, each of the hierarchically ordered groups (cohorts, orders, families, ribes, genera, species, etc.) in a classification of mammals may be regarded as he extension of a corresponding concept, such as the concepts of marsupial, bat, primate, and so on.

Analogously, the subclasses established by a particular taxonomic system of mental disorders are determined by the different kinds of mental illness conceptually distinguished in the system; for example, in the system of the *Diagnostic and Statistical Manual* of the American Psychiatric Association, the specification of the concept of psychotic depressive reaction serves to determine the class of those individuals to whom the concept applies, i.e., who suffer from that type of reaction. As this example illustrates, the objects of classification in psychiatric taxonomy are not the various kinds of mental disorder, but individual cases, which are assigned to various classes according to the kinds of mental disorder they exemplify. This construal accords perfectly with the conception of *diagnosis* as the assignment of individual cases to particular classes in a taxonomic system of diseases; and it is definitely called for by the use made of psychiatric classifications in medical statistics, which is concerned with the distribution of individual cases over the various classes provided in a classificatory system, such as that of the *International Statistical Classification of Diseases* or that of the *Diagnostic and Statistical Manual*.

An individual case of the kind here referred to is best understood to be a particular human being at a given time, or during a given time span, in his life history: this construal allows for the possibility that a person may belong to a class representing a certain illness at some time, but not at all times, during his life. (By contrast, the elements classified by a taxonomic system in biology are best considered to be individual organisms during their total life spans.)

Alternative ways of dividing a given universe of discourse into subclasses correspond to the use of alternative sets of concepts in singling out similarities and differences among the objects under consideration. Thus, the different typologies of physique and of temperament which have been developed from antiquity to the present employ different sets of concepts to classify or to type a given person. For example, one system of classifying individuals according to their temperaments is based on the concepts of extraversion and introversion, another on those of cerebrotonia, viscerotonia and somatotonia; another on the concepts of cycloid and schizoid temperaments, and so on; and the resulting classificatory or typological schemes differ accordingly.

Thus, the specification of a classificatory system requires a corresponding set of classificatory concepts: Each class provided for in the system is the *extension* of one of these concepts; i.e., it consists of just those objects in the universe of discourse which possess the specific characteristics which the concept represents. Hence, the establishment of a suitable system of classification in a given domain of investigation may be considered as a special kind of scientific concept formation. It seems reasonable therefore, in a methodological study of taxonomy, first to examine the basic functions of scientific concepts in general and then to consider what demands those intended functions impose upon classificatory concepts.

In our discussion, we will distinguish, in a manner widely accepted in contemporary logic, between *concepts* and the *terms* that stand for them; for example, the term 'soluble in alcohol' which is a linguistic expression, stands for the concept of solubility in alcohol, which is a property of certain substances. Collectively, the terms used by empirical science in general or by one of its branches will be referred to as its *vocabulary*.

3. DESCRIPTION AND THEORETICAL SYSTEMATIZATION AS TWO BASIC FUNCTIONS OF SCIENTIFIC CONCEPTS

Broadly speaking, the vocabulary of science has two basic functions: first, to permit an adequate *description* of the things and events that are the objects of scientific investigation; second, to permit the establishment of general laws or theories by means of which particular events may be *explained* and *predicted* and thus *scientifically understood*; for to understand a phenomenon scientifically is to show that it occurs in accordance with general laws or theoretical principles.

In fact, granting some oversimplification, the development of a scientific discipline may often be said to proceed from an initial "natural history" stage,[3]

3. This suggestive term is borrowed from Northrop (1947), especially chapters 3 and 4, where a distinction is drawn between "the natural history stage of inquiry" and the "stage of deductively formulated theory".

vhich primarily seeks to describe the phenomena under study and to establish imple empirical generalizations concerning them, to subsequent more and nore "theoretical" stages, in which increasing emphasis is placed upon the ttainment of comprehensive theoretical accounts of the empirical subject natter under investigation. The vocabulary required in the early stages of this levelopment will be largely observational: It will be chosen so as to permit the lescription of those aspects of the subject matter which are ascertainable fairly lirectly by observation. The shift toward theoretical systematization is marked oy the introduction of new, "theoretical" terms, which refer to various theoreti-:ally postulated entities, their characteristics, and the processes in which they ire involved; all these are more or less removed from the level of directly ob-;ervable things and events. For example, the electric and magnetic fields of physics, and the propagation of waves in them; chemical valences; molecular and atomic structures; elementary physical particles; quantum states: all these are typical of the sorts of things and processes to which the theoretical vocabulary of physics and of chemistry refers.

In medical science, the development from a predominantly descriptive to an increasingly theoretical emphasis is reflected, for example, in the transition from a largely symptomatological to a more and more etiological point of view. Etiology should not be conceived as dealing with the "causes" of disease in a narrow sense of that term. In the physical sciences, the search for causes in that sense has been replaced by a search for explanatory laws and theories; and etiology has been moving in the same direction. Indeed, the various theoretical approaches to disease have brought with them a variety of theoretical concepts. For example, the *Diagnostic and Statistical Manual* characterizes the concept of conversion reaction as follows:

> Instead of being experienced consciously, . . . the impulse causing the anxiety is "converted" into functional symptoms in organs or parts of the body, usually those that are mainly under voluntary control. The symptoms serve to lessen conscious (felt) anxiety and ordinarily are symbolic of the underlying mental conflict. Such reactions usually meet immediate needs of the patient and are, therefore, associated with more or less obvious "secondary gain." (pp. 32–33.)

Clearly, several of the terms used in this passage refer neither to directly observable phenomena, such as overt behavior, nor to responses that can be elicited by suitable stimuli, but rather to theoretically assumed psychodynamic factors. Those terms have a distinct meaning and function only in the context of a corresponding theory; just as the terms 'gravitational field', 'gravitational potential', and so on have a definite meaning and function only in the context of a corresponding theory of gravitation.

Let us now survey some of the requirements which the two major objectives of description and theoretical systematization impose upon scientific concepts, and in particular upon concepts used for classifactory purposes.

4. EMPIRICAL IMPORT OF SCIENTIFIC TERMS: OPERATIONAL DEFINITION

Science aims at knowledge that is *objective* in the sense of being intersubjectively certifiable, independently of individual opinion or preference, on the basis of data obtainable by suitable experiments or observations. This requires that the terms used in formulating scientific statements have clearly specified meanings and be understood in the same sense by all those who use them. One of the main objections against various types of contemporary psychodynamic theories, for example, is that their central concepts lack clear and uniform criteria of application, and that, as a consequence, there are no definite and unequivocal ways of putting the theories to a test by applying them to concrete cases.

A method that has been widely recommended to avoid this kind of deficiency is the use of so-called *operational definitions* for scientific terms. The idea was first set forth very explicitly by the physicist P. W. Bridgman in his book, *The Logic of Modern Physics*. An operational definition for a given term is conceived as providing objective criteria by means of which any scientific investigator can decide, for any particular case, whether the term does or does not apply. To this end, the operational definition specifies a testing "operation" T that can be performed on any case to which the given term could conceivably apply, and a certain outcome O of the testing operation, whose occurrence is to count as the criterion for the applicability of the term to the given case. Schematically, an operational definition of a scientific term S is a stipulation to the effect that S is to apply to all and only those cases for which performance of test operation T yields the specified outcome O. To illustrate: A simple operational definition of the term *harder than* as used in mineralogy might specify that a piece of mineral x is called harder than another piece of mineral y if the operation of drawing a sharp point of x under pressure across a smooth surface of y has as its outcome a scratch on y, whereas y does not thus scratch x. Similarly, an operational definition of length has to specify rules for the measurement of length in terms of publicly performable operations, such as the appropriate use of measuring rods. Again, phenylpyruvic oligophrenia might be operationally defined by reference to the "operation" of chemically testing the urine of the person concerned for the presence of phenylpyruvic acid; the "outcome" indicating the presence of the condition (and thus the applicability of the corresponding term) is simply a positive result of the test. Most diagnostic procedures used in medicine are based on operational criteria of application for corresponding diagnostic categories.

There are exceptions, however: For example, it has been suggested that the occurrence of a characteristic "praecox-feeling" in the investigator may count as one indication of dementia praecox in the patient he is examining; but this idea does not meet the requirements of operationism because the occurrence of the specified outcome, the praecox-feeling in regard to a given patient, is *not* independent of the examiner.

Bridgman argues in effect that if the meanings of the terms used in a scientific discipline are operationally specified then the assertions made by that discipline are capable of objective test. If, on the other hand, a proposed problem or hypothesis is couched in terms some of which are not thus tied to the firm ground of operationally ascertainable data, operationism rejects it as scientifically meaningless because no empirical test can have any bearing on it, so that the proposed formulation in turn can have no possible bearing on empirical subject matter and thus lacks empirical import.[4] The operationist insistence that meaningful scientific terms should have definite public criteria of application is thus closely akin to the empiricist insistence that meaningful scientific hypotheses and theories should be capable, in principle, of intersubjective test by observational data.

The methodological tenets of operationism and empiricism have met with especially keen, and largely favorable, interest in psychology and sociology. Here, an operational specification of meaning is often achieved by formulating definite testing procedures that are to govern the application of terms such as '*IQ*' and of terms pertaining to various aptitudes and attitudes.

The concern of many psychologists and social scientists with the *reliability* of their terms reflects the importance attributed to objectivity of use: The reliability of a concept (or of the corresponding term) is usually understood as an indicator of two things: the consistency shown in its use by one observer, and the agreement in the use made of it by different observers. The former feature is often expressed in terms of the correlation between the judgments made by the same observer when he is asked to judge the same case on several occasions; the latter feature is expressed in terms of the correlations obtaining among the judgments of several observers judging the same cases; the "judgments" here referred to being made in terms of the concept whose reliability is under consideration.

The operationist emphasis on clear and precise public criteria of application for scientific terms is no doubt sound and salutary. But the customary formulations of operationism require certain qualifications, two of which will be briefly mentioned here because they are relevant to the subject matter of this paper.

4. Cf., for example, Bridgman, p. 28.

First, the operational criteria of application available for a term often amount to less than a full definition. For example, criteria of application for the term *temperature* may be specified by reference to the operation of putting a mercury thermometer into the appropriate place and noting its response; or by similar use of an alcohol thermometer, or of a thermocouple, and so on. These instruments have different, though partly overlapping, ranges within which they can be used, and none covers the full range of theoretically possible temperatures. Each of them thus provides a *partial definition*, or better, a *partial criterion of application*, for the term under consideration (or for the corresponding concept). Such partial criteria of application for the terms occurring in a given hypothesis or theory will often suffice to make an empirical test possible. Indeed, there are reasons to doubt the possibility of providing *full* operational definitions for all theoretical terms in science, and the operationist program needs therefore to be liberalized, so as to call only for the specification of partial criteria of application.[5]

Secondly, if the insistence on an *operational* specification of meaning for scientific terms is not to be unduly restrictive, the idea of operation has to be taken in a very liberal sense which does not require manipulation of the objects under consideration: the mere observation of an object, for example, must be allowed to count as an operation. For criteria of application for a term may well be specified by reference to certain characteristics which can be ascertained without any testing procedure more complicated than direct observation. Consider, for example, the check list of characteristics which Sheldon gives for dominant endomorphy. That list includes such directly observable features as roundness and softness of body; central concentration of mass; high, square shoulders with soft contours; short neck; short tapering limbs.[6] This is a satisfactory way of determining the concept of predominant endomorphy and thus the class of predominantly endomorphic individuals, provided that the terms used to specify the distinctive characteristics of endomorphs have a reasonably precise meaning and are used, by all investigators concerned, with high intersubjective uniformity; i.e., provided that, for any given subject, there is a high degree of agreement among different observers as to whether or not the subject has soft body contours, a short neck, tapering limbs, and so on. And indeed, Bridgman's insistence on operational tests and their outcomes is no doubt basically aimed at making sure that the criteria of application for scientific concepts be expressed in terms which have a very high uniformity of usage.

It would be unreasonable to demand, however, that *all* the terms used in a

5. For a more detailed discussion of these issues, see Hempel (1958).

6. See Sheldon, Stevens, and Tucker (1940), p. 37. For detailed somatotyping, measurement of a number of diameters on the body surface, and thus the "operation" of applying suitable measuring devices, is required; cf. *loc. cit.*, chapter 3.

iven scientific discipline be given an operational specification of meaning; for hen, the process of specifying the meanings of the defining terms, and so forth, vould lead to an infinite regress. In any definitional context (quite independently if the issue of operationism), some terms must be antecedently understood; and he objectivity of science demands that the terms which thus serve as a basis for he introduction of other scientific terms should be among those used with a ıigh degree of uniformity by different investigators in the field.

For just this reason, the operational criteria of application for psychological erms are usually formulated by reference to publicly observable aspects of the ɔehavior a subject shows in response to a specified publicly observable stimulus ituation, and this does indeed seem to be the most satisfactory way of meeting he demands of scientific objectivity. Reference to "operations" of a highly introspective and subjective character does not meet the requirements of scientific concept formation; for example, the operational reformulation of psychoanalytic concepts proposed by Ellis,[7] which relies on such "operations" as thinking, remembering, emoting, and perceiving (in an enormously comprehensive sense) provides no clear criteria of application for the terms of psychoanalysis and no objective ways of testing psychoanalytic hypotheses.

To apply the preceding considerations to the taxonomy of mental disorders: If a classificatory scheme is to be used with a high degree of uniformity by different investigators, the concepts determining the various subclasses will have to possess clear criteria of application that can be stated in terms of publically ascertainable characteristics. The importance of objective criteria of classification, or of objective diagnostic criteria, seems to me to be strikingly illustrated by observations made in some of the other papers prepared for this conference. For example, Professor Stengel[8] mentions in his contribution that among the cases admitted to mental hospitals in England and Wales during 1949, a quite improbably small fraction were assigned to the categories 315 to 317 (psychoneuroses with somatic symptoms) of the *International Statistical Classification of Diseases;* and the question arises whether lack of clearly specified criteria of application may not account in part for this apparent anomaly. Another case in point is Professor Greenberg's observation that not infrequently, technicians, assistants, and even coinvestigators engaged in a common research project differ among each other in their interpretations of the meanings of terms, disease conditions, and procedures when these are not specified in writing. In a similar vein, Professor Strömgren notes that many of the controversies between research workers in psychiatric demography can easily be traced back to inconsistencies of definition.

But while the formulation of more reliable criteria of application is certainly

7. Cf. Ellis (1956).

8. This contribution and others, soon to be cited, are included in Zubin (1961).

very desirable, it is not, I am sure, always an easy task. Professor Strömgren gives some illustrations of this point in his paper. It would therefore be unreasonable and self-defeating to insist on the highest standards of precision from the beginning; but it is important to aim at increasingly reliable criteria of application for the various categories distinguished in a classification of mental disorders.

In the interest of this objective, it may be worth considering whether, or to what extent, criteria with valuational overtones are used in the specification of psychiatric concepts. Consider, for example, the characterization of the category "Inadequate personality" as given in the *Diagnostic and Statistical Manual* (p. 35): "Such individuals are characterized by inadequate response to intellectual, emotional, social, and physical demands. They are neither physically nor mentally grossly deficient on examination, but they do show inadaptibility, ineptness, poor judgment, lack of physical and emotional stamina, and social incompatibility." Such notions as inadequacy of response, inadaptability, ineptness, and poor judgment clearly have valuational aspects, and it is to be expected that their use in concrete cases will be influenced by the idiosyncrasies of the investigator; this will reduce the reliability of these concepts and of those for which they serve as partial criteria of application.

One interesting way of increasing uniformity in the intersubjective use of certain classificatory terms has been pointed out by Lazarsfeld and Barton: Some kinds of classificatory judgment become more reliable when the "indicators," the criteria that serve to assign individual cases to specific classes, are broken down into several components. For example, when several classifiers judge children's adjustment, reliability will be increased by simply specifying certain aspects to which the classifiers are to pay attention, such as appearance (which in turn may be further characterized by means of such sub-indicators as excessively untidy hair and clothing, chewed fingernails, rigid facial expression); response to interviews; attitude towards others and toward self. The authors add, significantly, that despite the increase in objectivity thus achieved, there "is still required, however, a certain body of common training and experience, such as might be found among trained child psychologists, to make a vague procedure work at all well."[9]

Another factor that may affect the reliability of classificatory criteria is illustrated by the Rorschach test, the thematic apperception test, and similar procedures, all of which may be regarded as providing operational criteria for diagnostic purposes. These tests differ from, say, intelligence or aptitude tests of the customary kind in that they require a good deal of interpretation, and that

9. See Lazarsfeld and Barton (1951), especially pp. 166-167.

there is no simple routine—performable, in principle, by a machine, as it were—of noting the subject's responses and combining them into an unequivocal diagnosis that assigns the subject to some particular class.

Similar observations apply to Sheldon's typology of temperaments. For diagnostic assignment of an individual subject to one of the various types distinguished in the system, the examiner has to rate the subject with respect to a specified list of traits; and while there is likely to be rather close agreement among the ratings made by different examiners, Sheldon and Stevens[10] add this comment on the procedure:

> The later (diagnostic) use of the traits, considering the traits individually, is perhaps about as objective and systematic as medical diagnosis. That is to say, we admit freely that a subjective element is present—that no machine has been built which can make a diagnosis of temperament.

However, the objectivity, or intersubjectivity, here under discussion is of course a matter of degree, and it should be remembered that also the results of such "operations" as observing an object by microscope or telescope, or a lung via fluoroscope or indirectly through an X-ray photograph, show intersubjective variation even among expert observers.[11] What matters is, I think, to be aware of the extent to which subjective factors enter into the application of a given set of concepts, and to aim at a gradual reduction of their influence.

5. SYSTEMATIC IMPORT AND "NATURAL" CLASSIFICATION

But clear and objective criteria of application are not enough: to be scientifically useful a concept must lend itself to the formulation of general laws or theoretical principles which reflect uniformities in the subject matter under study, and which thus provide a basis for explanation, prediction, and generally scientific understanding. This aspect of a set of scientific concepts will be called its *systematic import*, for it represents the contribution the concepts make to the systematization of knowledge in the given field by means of laws or theories.

The requirement of systematic import applies, in particular, also to the concepts that determine scientific classifications. Indeed, the familiar vague distinction between "natural" and "artificial" classifications may well be explicated as referring to the difference between classifications that are scientifically fruitful and those that are not: in a classification of the former kind, those characteristics of the elements which serve as criteria of membership in a given class are associated, universally or with high probability, with more or less extensive clusters of

10. Sheldon and Stevens (1942), p. 426.

11. See Chapter 1 of Hanson (1958) for an instructive discussion of scientific seeing and observing as "theory-laden" undertakings.

other characteristics. For example, the two sets of primary sex characteristics which determine the division of humans into male and female are each associated, by general laws or by statistical connections, with a large variety of concomitant physical, physiological, and psychological traits. It is understandable that a classification of this sort should be viewed as somehow having objective existence in nature, as "carving nature at the joints," in contradistinction to "artificial" classifications, in which the defining characteristics have few explanatory or predictive connections with other traits; as is the case, for example, in the division of humans into those weighing less than one hundred pounds, and all others. (This is not to deny that the latter distinction, as well as other, similarly "artificial" ones, may be very useful for certain special practical purposes, as is, for example, the classification of fingerprints for the identification of individuals, although the systematic import of the system would seem to be quite small.)

Similarly, as W. S. Jevons pointed out (before the periodic system had been published), the elements potassium, sodium, caesium, rubidium, and lithium, which are grouped together as forming the class of alkali metals, have a great many characteristics in common: they all combine energetically with oxygen, decompose in water at various temperatures, and form strongly basic oxides that are highly soluble in water; their carbonates are soluble in water, and so forth.[12] Perhaps the most striking example of a classification reflecting general laws is the periodic system of the elements, on which Mendeleev based a set of highly specific predictions, which were impressively confirmed by subsequent research. As a result of more recent advances, the system, in a somewhat revised form, has been given a deeper theoretical foundation by showing that it reflects, in the classes represented by the columns of the periodic table, certain similarities and differences in the atomic structure of the elements.

A similar development has taken place in the taxonomic methods of biology. Even in the early taxonomic systems, which are based on more or less directly observable (largely morphological) characteristics, each class represents of course a large bundle of empirically associated traits; but, as an outgrowth of the theory of evolution, the morphological basis of classification came to be replaced by one more deeply imbedded in theory, namely a phylogenetic basis. The various species, for example, are "theoretically defined, at least in principle, in phylogenetic and genetic terms,"[13] and the morphological characteristics

12. Jevons (1877), p. 675. See also Jevons' illuminating general discussion in Chapter 30 of his book.

13. Simpson (1945), p. 13. See also the lucid exposition of the same subject in Chapter 19, "The principles of classification," in Simpson, Pittendrigh, and Tiffany (1957). Concerning the systematic import of classificatory concepts in biological taxonomy, see the essays by Huxley and by Gilmour in Huxley (1940).

now provide simply the observational criteria for the assignment of individuals to a species which is construed in phylogenetic terms.

In psychological and psychopathological research the typological systems of Kretschmer[14] and of Sheldon and his associates, to mention two characteristic examples, illustrate the strong interest in concepts reflecting empirical uniformities and statistical associations. In Sheldon's system the three "primary components of temperament"—viscerotonia, cerebrotonia, and somatotonia—are characterized by means of three corresponding clusters of traits which were selected, on the basis of much empirical trial and error, in such a way that the traits in each group would intercorrelate positively with each other and show a negative correlation with all or nearly all the traits in the other groups.[15] In addition, one of the principal claims to scientific significance that are suggested for the system rests on the correlation between the three components of temperament on the one hand and various other psychological and somatic traits on the other; in regard to the latter, certain statistical connections are indicated between the basic components of temperament and the basic components of physique—endomorphy, ectomorphy, and mesomorphy—which are distinguished in Sheldon's theory of somatic types.[16] Kretschmer's typology of character and physique has similar objectives; and both systems attempt to exhibit some connections between somatic characteristics and a disposition to certain kinds of mental disturbance. Whatever the merits of these and similar systems may prove to be, they are mentioned here as instances of a deliberate effort to develop classificatory systems (more precisely: typologies in the sense to be discussed in the next section) whose conceptual basis has definite systematic import.

In accordance with the requirement of systematic import, the concepts used in a given field of scientific inquiry will change with the systematic advances made in that field: the formation of concepts will go hand in hand with the formulation of laws and, eventually, of theories. As was mentioned earlier, the laws may at first express simple uniform or statistical connections among observables; they will then be formulated in terms of the observational vocabulary of the discipline to which they belong. Further systematic progress, however, will call for the formulation of principles expressed in theoretical terms which refer to various kinds of unobservable entities and their characteristics. In the course of such development, classifications defined by reference to manifest, observable characteristics will tend to give way to systems based on theoretical

14. See Kretschmer (1925).

15. See Sheldon and Stevens (1942), chapter 2.

16. See Sheldon, Stevens, and Tucker (1940), especially chapter 7, and Sheldon and Stevens (1942), chapter 7.

concepts. This process is illustrated, for example, by the shift from an observational-phenomenal characterization and classification of chemical elements and compounds to theoretical modes of defining and differentiating them by reference to their atomic and molecular structures. To be unequivocally applicable to concrete cases, the theoretically specified concepts must, of course, possess clear-cut empirical, or "operational," criteria of application; but these can no longer be regarded as their defining characteristics: the specified outcome of the operational test just constitutes a readily observable *symptom* for the presence of the traits or processes represented by the theoretical concepts; the "meanings" of the latter are not fully reflected by operational-symptomatic criteria of application (diagnosis) alone, but quite importantly also by the theoretical system to which they belong.

The emphasis on systematic import in concept formation has been clearly in evidence in the development of classificatory systems for mental disorders, The concepts determining the various classes or categories distinguished now are no longer defined just in terms of symptoms, but rather in terms of the key concepts of *theories* which are intended to *explain* the observable behavior, including the symptoms in question; just as molecular and atomic theory accounts for the more directly observable characteristics that served as defining characteristics in an earlier stage of chemical concept formation. The trend is nicely illustrated by several of the characterizations of mental disorders given in the *Diagnostic and Statistical Manual*, where an enumeration of certain symptoms is combined with an etiological or generally theoretical account: the characterizations of the various categories of psychoneurotic disorders (pp. 31-34 of the *Manual*) are clear cases in point.

In a classificatory system with a theoretical basis, two individuals with similar symptoms may then come to be assigned to quite different classes; for some of the kinds of mental disturbance distinguished at the etiologic-theoretical level may well partially overlap in the associated syndromes, just as two different chemical compounds may have various directly observable characteristics in common. Similarly, in taxonomic systems of biology which have a phylogenetic-evolutionary basis, two phenomenally very similar specimens may be assigned to species far removed from each other in the evolutionary hierarchy, such as the species Wolf (*Canis*) and Tasmanian Wolf (*Thylacinus*).[17]

The preceding considerations have some bearing on the question whether prognostic prospects and therapeutic possibilities may—or perhaps even ought to—be properly included among the defining characteristics of a mental illness.

17. For this and other examples see chapter 19 of Simpson, Pittendrigh, and Tiffany (1957).

It is certainly conceivable—and indeed to be hoped for as a result of further research—that concepts representing mental disorders should be used in a theoretical context which carries certain prognostic implications. In this case, the concepts in question might be defined, within the framework of the theory, by means of characteristics some of which are prognostic in character. On the other hand, it would defeat the practical purposes of diagnosis and therapy if the operational criteria of application for those concepts, i.e., the criteria forming the basis of medical diagnosis, required postponement of the diagnosis until after the illness had run its course. If they are to meet those practical needs, the criteria of application will therefore have to be couched in terms of characteristics that can be ascertained more or less immediately. To mention a parallel from physics: It would be unfortunate if the application of the term *radium* depended on the criterion that the half-life of radium is approximately 1800 years; though this half-life is certainly an important characteristic of radium.

We should note, however, that the distinction here assumed between prognostic and nonprognostic criteria of application is a matter of degree. Operational definitions, for example, imply conditional prognoses concerning the outcome of certain test operations: If x is a harder piece of mineral than y then the scratch test will result in a scratch mark on the surface of y; if a current of one ampere is flowing through that wire, the needle of a properly connected ammeter will respond accordingly; and so forth. Similarly, the Schick test, which provides an operational criterion of application for the concept of immunity to diphtheria, involves a short-range prognosis concerning a skin reaction. And in certain cases, response to particular forms of therapy might be resorted to as a diagnostic criterion. But it seems reasonable to expect that advances in theoretical understanding will increasingly provide us with etiological or structural accounts of physical and mental illness, and that these in turn will imply diagnostic criteria in terms of antecedent conditions or presently ascertainable physical or mental characteristics.

It is very likely, I think, that classifications of mental disorders will increasingly reflect theoretical considerations. It is not for me to speculate on the direction that theoretical developments in this field may take and especially on whether the major theories will be couched in biophysiological or biochemical terms or rather in psychodynamic terms that lack an over-all physiological or physiochemical interpretation. Theoretical systems of either kind can satisfy the basic requirements for scientific theories. In brief and schematic outline, these requirements call for (1) a clear specification of the basic concepts used to represent the theoretical entities (objects, states, processes, characteristics, and so on) in terms of which the theory proposes to interpret, and account for, the empirical phenomena in its domain of investigation; (2) a set of theoretical assumptions (basic

laws, fundamental hypotheses) couched in theoretical terms and asserting certain interrelations among the corresponding theoretical entities; (3) an empirical interpretation of the theory, which might take the form of operational criteria for the theoretical terms or, more generally, the form of a set of laws, statistical or strictly universal in character, connecting the theoretical traits, states, or processes with observable phenomena; (4) testability-in-principle of the theory thus specified; i.e., the theory together with its interpretation, must imply, deductively or inductively, definite assertions about observable phenomena that should be found to occur under specifiable test conditions if the theory is correct: the occurrence or nonoccurrence of these phenomena will then provide confirming or disconfirming evidence concerning the theory. If a proposed theory has no such implications at all, it clearly has no possible bearing on empirical subject matter and thus cannot qualify as a significant theory in empirical science (not even as an unsound or false one: for these latter attributes presuppose a conflict between the theory and relevant experimental or observational evidence).[18]

This requirement of testability by reference to observable phenomena rules out, for example, the neo-vitalistic conception of biological processes as being determined, at least in part, by vital forces or entelechies; for the available statements of this conception yield no experimentally testable implications.

6. FROM CLASSIFICATORY TO COMPARATIVE AND QUANTITATIVE CONCEPTS

While it is not possible to predict the substantive changes that the concepts and theories of mental disorder will undergo as a result of further research, I think that certain changes in their logical character may well be anticipated. In this concluding section, I will attempt briefly to indicate the nature of these changes.

Classification, strictly speaking, is a yes-or-no, an either-or affair: A class is determined by some concept representing its defining characteristics, and a given object falls either into this class or outside, depending on whether it has or lacks the defining characteristics.

In scientific research, however, the objects under study are often found to resist a tidy pigeonholing of this kind. More precisely: those characteristics of the subject matter which, in the given context of investigation, suggest themselves as a fruitful basis of classification often cannot well be treated as properties which a given object *either* has *or* lacks; rather, they have the character of traits

18. For a fuller account of these principal requirements and a critical analysis of some of their consequences, see Hempel (1952), (1958).

which are capable of gradations, and which a given object may therefore exhibit *more or less* markedly. As a result, some of the objects under study will present the investigator with borderline cases, which do not fit unequivocally into one or another of several neatly bounded compartments, but which exhibit to some degree the characteristics of *different* classes. For example, Professor Strömgren refers in his paper to the difficulties of finding a natural border line separating the whole group of neuroses and psychopathies from that which does not belong to it, and he remarks that the transitions are gradual in all directions. Typologies of physique and of temperament provide another good illustration, and one in which the gradual character of the transition has recently received some special methodological attention. The proponents of typological systems often emphasize that "pure" instances of the basic types they distinguish are rarely, if ever, encountered in experience, and that concrete individuals usually represent mixtures of several types. Sometimes, the basic types acquire the status of ideal reference points which mark, as it were, the ends of a scale along which concrete cases can be arranged. Thus, Kretschmer[19] states:

> We never, even in the most definite cases, come across a pure example in the strictest sense of the word, but always the peculiar individual instances of a type, that is the type itself mixed with slight accretions out of a heterogeneous inheritance. This mixture, in the guise of which the type appears to us in any individual instance, we call the *constitutional alloy*.

Metaphorical statements of this kind are suggestive; but they are not sufficient for the formulation of a theory that is to take explicit and objective account of those impure cases. A conceptual apparatus is needed to describe and distinguish constitutional alloys in which the characteristics of the pure types are represented with different strengths. For example, to give a clear, objective meaning to the notion of a pure type, say A, which different individuals may represent in different degrees, objective criteria are required which will determine for any two individuals whether they represent type A with equal strength, and if not, which of them represents A more strongly than does the other. Suitable criteria of this kind will effect, not a division of the universe of discourse into two classes, A and *non-A*, but a simple (quasi-linear) ordering of the universe. In this ordering, two individuals will "coincide," i.e., occupy the same place, if, in the sense of the criteria, they exhibit A with equal strength; whereas individual x will precede individual y if, in the sense of the criteria, x is a less pronounced case of A than is y.

A parallel from physics may serve to illustrate the point: A simple ordering of minerals according to increasing hardness can be effected by means of the

19. Kretschmer (1925), p. 93.

scratch-test criterion mentioned earlier: if a sharp point of y scratches a surface of x, but not vice versa, y is harder than x and thus follows x in the order of increasing hardness; if neither y is harder than x nor x harder than y, both minerals are assigned the same place in the quasi-linear order. This example illustrates two elementary but important points: (1) The "diagnostic" criteria which serve to place individual cases in the scheme are not criteria of class-membership, as they would be in a strictly classificatory system; rather, they are criteria of precedence and coincidence in a quasi-linear order. (2) such criteria can be quite objective and rather precise without presupposing quantitative measurement.[20]

We noted that recent typological systems have, in effect, replaced a strictly classificatory procedure by an ordering one (even though some of them use a classificatory terminology and supplement it by speaking metaphorically of borderline cases, mixtures, transitional forms, and the like). Such reliance on concepts and methods of an ordering character is illustrated not only by Kretschmer's system, but also, to mention just a few other examples, by C. G. Jung's distinction of the extraverted and introverted types, by E. R. Jaensch's typology[21] and by the system developed more recently by Sheldon in collaboration with Stevens and others. This latter theory, however, makes the ordering character of its basic concepts quite explicit and seeks to satisfy the requirement of objectivity (in the sense discussed earlier) for the diagnostic criteria it sets down.

Since each of the types distinguished in a typological theory will represent at least one quasi-linear ordering, typological systems usually provide for an arrangement of individuals along several axes, and thus replace classificatory schemes by reference "spaces" of several "dimensions."

The advantages of ordering over classification can be considerable. In particular, ordering allows for subtler distinctions than classification; furthermore, ordering may take the special form of a quantitative procedure, in which each dimension is represented by a quantitative characteristic. And quantitative concepts not only allow for a fineness and precision of distinction unparalleled on the levels of classification and of nonquantitative ordering, but also provide a basis for the use of the powerful tools of quantitative mathematics: laws and theories can be expressed in terms of functions connecting several variables, and consequences can be derived from them, for purposes of prediction or of test, by means of mathematical techniques.

The considerations presented in this section and in the preceding one suggest that the development of taxonomic concepts in the study of mental disorder will

20. For a detailed analysis of ordering procedures, with special reference to typological theories, see Hempel and Oppenheim (1936); a short general account of the logic of classification, ordering and measurement is given in Hempel (1952), Part III.

21. See, for example, Jung (1921), Jaensch (1933).

probably show two trends: First, a continuation of the shift from systems defined by reference to observable characteristics to systems based on theoretical concepts; and second, a gradual shift from classificatory concepts and methods to ordering concepts and procedures, both of the non-quantitative and of the quantitative varieties.

REFERENCES

American Psychiatric Association, *Diagnostic and Statistical Manual: Mental Disorders.* Washington, D. C., 1952.

Bridgman, P. W., *The Logic of Modern Physics.* New York, Macmillan, 1927.

Ellis, Albert, "An Operational Reformulation of Some of the Basic Principles of Psychoanalyis." In Feigl, H., and Scriven, M., eds., *Minnesota Studies in the Philosophy of Science*, vol. I. Minneapolis, University of Minnesota Press, 1956, pp. 131-154.

Gregg, John R., *The Language of Taxonomy*, New York, Columbia University Press, 1954.

Hanson, N. R., *Patterns of Discovery.* London, Cambridge University Press, 1958.

Hempel, Carl G., *Fundamentals of Concept Formation in Empirical Science.* Chicago, University of Chicago Press, 1952.

Hempel, Carl G., "The Theoretician's Dilemma." In Feigl, H., Scriven, M., and Maxwell G., eds., *Minnesota Studies in the Philosophy of Science*, vol. II. Minneapolis, University of Minnesota Press, 1958, pp. 37-98 (Reprinted in this volume).

Hempel, Carl G., and Oppenheim, P., *Der Typusbegriff im Lichte der neuen Logik.* Leiden, Sitjhoff, 1936.

Huxley, J., *The New Systematics.* Oxford, Clarendon Press, 1940.

Jaensch, E. R., *Die Eidetik und die typologische Forschungsmethode.* Leipzig, Quelle und Meyer, 1933.

Jevons, W. S., *The Principles of Science*, 2nd ed., 1877; reprinted, with a new introduction by Ernest Nagel. New York, Dover Publications, 1958.

Jung, C. G., *Psychologische Typen.* Zurich, Rascher, 1921.

Kretschmer, E., *Physique and Character.* Translated from second German edition by W. J. H. Sprott. New York, Harcourt, Brace and Co., 1925.

Lazarsfeld, P., and Barton, A. H., "Qualitative Measurement in the Social Sciences: Classification, Typologies, and Indices" In: Terner, D., and Lasswell, H. eds., *The Policy Sciences.* Stanford: Stanford Univ. Press, 1951, pp. 155-192.

Northrop, F. S. C., *The Logic of the Sciences and the Humanities.* New York, Macmillan, 1947.

Sheldon, W. H., and Stevens, S. S., *The Varieties of Temperament.* New York, Harper & Brothers, 1942.

Sheldon, W. H., and Tucker, W. B., *The Varieties of Human Physique.* New York, Harper & Brothers, 1940.

Simpson, George G., *The Principles of Classification and a Classification of Mammals.* Bulletin of the American Museum of Natural History, vol. 45. New York, 1945.

Simpson, George G., Pittendrigh, C. S., and Tiffany, L. H., *Life: An Introduction to Biology.* New York, Harcourt, Brace and Co., 1957.

Zubin, J., ed., *Field Studies in the Mental Disorders.* New York, Grune and Stratton, 1961.

7. TYPOLOGICAL METHODS IN THE NATURAL AND THE SOCIAL SCIENCES

1. INTRODUCTION

THE CONCEPT of type has played a significant role in various phases of the development of empirical science. Many of its uses are by now of historical interest only; but some branches of research, especially psychology and the social sciences, have continued up to the present to employ typological concepts for descriptive and for theoretical purposes. In particular, various typologies of character and physique have been propounded as providing fruitful approaches to the study of personality; the investigation of "extreme" or "pure" types of physical and mental constitution has been advocated as a source of insight into the functioning of "normal" individuals; and as for social science, the use of ideal types has been declared one of the methodological characteristics which distinguish it essentially from natural science.

Considering these recent uses of typological concepts and the various claims concerning their peculiar significance, it appears to be a matter of some interest and importance to have a reasonably clear understanding of their logical status and their methodological function. Now, there exists a voluminous literature on the subject, but a large part of it suffers from a definite inadequacy of the logical apparatus used for the analysis of the issues at hand. In particular, many of the studies devoted to the logic of typological concepts use only the concepts and principles of classical logic, which is essentially a logic of properties or classes, and cannot deal adequately with relations and with quantitative concepts. It is illustrative of this situation that Max Weber, who so eloquently champions the method of ideal types in the social sciences, makes a clear negative statement about their logical status: they cannot be defined by *genus proximum* and *differentia*