make predictions about future states of affairs. Whenever people agree among themselves that understanding has been more or less satisfactorily achieved or that predictions have proved accurate within agreed-to limits of error, then the theoretical models will continue to be favored. Thus, the continuing viability of a theory rests on human consensus.

The Tasks Ahead

From this point on we will deal with the parts of theoretical models and their interrelationships. It should always be kept in mind that the parts are intended to be fitted together into a whole model. The illustrative theory used in this chapter provides an example of how you can retain a grasp of the whole theoretical model even while dissecting it into its component parts.

CHAPTER TWO

Theory

Theories are nets cast to catch what we call "the world": to rationalize, to explain, and to master it. We endeavour to make the mesh ever finer and finer.

-Karl R. Popper, The Logic of Scientific Discovery

It is appropriate to include in a book called Theory Building a chapter titled "Theory." Lest there be disappointment that the usual "fundamental" and sometimes turgid treatment of this topic is not found here, let me hasten to assert that only two simple purposes will be served by this chapter. My first purpose is to make clear the distinction between asking a question and doing research. This distinction is not always kept in mind by behavioral scientists. The second purpose is to present two contrasting goals of science and to show that these are coordinate, but not dependent, goals of scientific activity.

This entire volume is concerned with theory and theory building. I will take a series of ordered steps to put the whole of it together. This chapter sets the stage for what follows in the remaining ten. If the subjects of this chapter hold no interest for you, or if you have immediate need to build a theory, then you may wish to turn at once to Chapter 3, where the analysis of theory building proper begins.

Theory and Questions

It is notable in all sciences, but particularly in the behavioral sciences, that a scientist's reputation may be based upon his sole possession of a body of data. The man who first examines, describes, and reports some facts of the observable world is honored for this accomplishment.¹ It is

¹There are many examples. For instance, the classic works of Lorenz in ethology, Burgess on the structure of the city, Sheldon in describing soma-types, and Booth in describing life and labor in London.
right and proper that he be so honored for he is contributing information or data to the body of knowledge.

Without gainsaying the contribution made by the addition of information to the body of knowledge, it is important to ask whether the ability to make such a contribution depends upon being a scientist (i.e., using that much abused procedure called scientific method) or is the product of being a good reporter. I think the answer is very clear. Good reporters can contribute new and sometimes important information to the body of knowledge. Good (or even bad) scientists can do the same thing, doing so not because they are scientists but because they are good reporters.

What, then, is the distinction between reporting and "doing science"? The distinction lies in whether the information is gathered for its own sake, or whether it is used to measure the values associated with "things" (called units of a theory, as elaborated in Chapter 4, and loosely called variables when talking about theories), the relationships among two or more of which is the focus of attention. The first procedure we call description; the second we call research.

Description and research are both part of scientific activity but contribute to it in distinctive ways. In Chapters 4, 6, 7, and 9, we will see how description contributes to the selection of units of a scientific model, to the location of its boundaries, to the determination of the system states in which it is to be found, and to the development of empirical indicators for measuring the values of the theoretical units employed.

I assume as a starting point that research is more than question asking. A piece of research tests an hypothetical prediction. The prediction, in turn, has antecedents in an explicit or implicit theoretical model. The research test of the prediction always provides a feedback to the model from which it is derived, either to substantiate the model's continued viability or to require its modification.

The general form of an hypothesis is a conditional prediction about the relationship between two or more things, followed by a figurative question mark. The question mark is the shorthand way of saying, "This prediction must be tested by marshaling measurements of these things in the observable world to see if their values predicted by the theoretical relationship can be empirically duplicated." The test of an hypothesis always relates back to the theory from which it derived. The rejected hypothesis requires the modification of the generating theoretical model or the reference of the results to an alternate model. The confirmed hypothesis requires a renewed research for further tests of the theory.

By way of contrast with an hypothesis, a question can stand alone, having neither antecedent questions from which derived nor succeeding questions to which it gives rise. When I ask, "How will you vote tomorrow?" or "Do you approve of the policies of the Administration?" and you answer, the information is in. An observer or reporter answers questions; a researcher tests predictions.

It is symbolic that the activities of scientists are called research. Separated into parts, the activities of research are a re-search—activities undertaken to repeat a search. The dictionary defines research as "a critical and exhaustive investigation or experimentation having as its aim the revision of accepted conclusions, in the light of newly discovered facts." The scientist is constantly concerned with re-searching the accepted conclusions of his field—the theoretical models he uses. He does this re-searching by probing for facts of the empirical world that falsify one or more predictions generated by his accepted conclusions, or theoretical models. Then the re-searching turns to the construction of new theoretical models to take the place of those no longer able to make sense out of the empirical world.

If we agree that research is more than answering questions, in the sense just indicated, an obvious conclusion follows. Theorizing as an integral part of empirical investigation, just as empirical analysis has meaning only by reference to a theory from which it is generated.

It is customary to view the relationship between theory and research from the vantage point of the former. This leads to asking, "What does research do for theory in the way of testing its utility, or correspondence with reality?" If we turn it around and assume that scientists will do research as a normal activity in their subculture, we may then ask, "What is there about theory that has usefulness for the working researcher?"

These two questions meet at some point of the scientific enterprise. But the answers are significantly determined by the direction from which one approaches the meeting point. Coming from theory to research, attention is focused on truth, the nature of reality, the processes of knowing, and the logic of meaning statements. Starting from research and moving toward theory, attention turns to such issues as measurement in all its phases, translation of propositions into operational terms, and the reliability of empirical indicators.

There has been some tendency in the literature dealing with the connections between theory and research for the travelers to move toward each other from their respective starting points in either theory or research but to fail ever to meet head-on at any point of their journeys. Insofar as it seems to make sense to do so, this book is dedicated to producing a smashing collision on the highway connecting theory and research. The purpose is to generate a genuinely useful result (just as atom smashing produces new knowledge) rather than a pile of debris.

There has come increasingly into current usage the term model as a
argued that these are separate goals and that the structure of theories employed to achieve each is unique. I will not, however, conclude that they are either inconsistent or incompatible. In the usual case of theory building in behavioral sciences, understanding and prediction are not often achieved together, and it therefore becomes important to ask why. It will be concluded that each goal may be attained without reference to the other.

I mean one of two things by prediction: (1) that we can foretell the value of one or more units making up a system; or (2) that we can anticipate the condition or state of a system as a whole. In both instances the focus of attention is upon an outcome.

As I employ the term understanding, it has the following essential meaning: it is knowledge about the interaction of units in a system. Here attention is focused on processes of interaction among variables in a system.

The relationships between the goals of science and the analytical foci of attention in achieving these goals can be shown in a fourfold table like Table 2-1.

At first glance one would normally be constrained to argue that the four boxes of the table are simultaneously populated. That is, to achieve understanding of a social system, we need to know the interaction processes in it and the outcomes generated by these processes. Similarly, if we are to make accurate predictions about social phenomena, we have to know the processes built into these phenomena and the characteristics of all possible outcomes toward which the processes move. This initial reaction is simply the assertion of a pious value position that bears little relation to the practices of social scientists. They actually operate in theory building and in doing research by working primarily in two of the four boxes, as indicated by the X entries in Table 2-1. What seems, in a

Goals of Science

Theories of social and human behavior address themselves to two distinct goals of science: (1) prediction and (2) understanding. It will be

Chapter VII, in which five types are distinguished. See also H. Freudenthal (ed.), The Concept and the Role of the Model in Mathematics and Natural and Social Sciences (Dordrecht, Holland: D. Reidel Publishing Co., 1961).

It will be recognized that this is not the same as verstehen sociology whose essential feature is the claim that the observer, being identical with his subjects, is able to "take the role of the other" (think, act, and feel like) when analyzing social phenomena, and hence can understand from the standpoint of the subjects being studied. My emphasis on interaction is identical with that of G. Bergmann who speaks of "process knowledge" and its interaction feature, which is the complete knowledge of the interaction among the variables of a system. See his "Purpose, Function, Scientific Explanation," Acta Sociologica, 5:225–238 (1962), and also his Philosophy of Science (Madison, Wisc.: University of Wisconsin Press, 1957).

An excellent discussion of the distinction between understanding and prediction will be found in Kaplan, op. cit., pp. 346ff.

Table 2-1.

<table>
<thead>
<tr>
<th>Analytical Focus</th>
<th>Goals</th>
</tr>
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<tbody>
<tr>
<td>Understanding</td>
<td>Prediction</td>
</tr>
<tr>
<td>Interaction</td>
<td>X</td>
</tr>
<tr>
<td>Outcomes</td>
<td>X</td>
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</tbody>
</table>

logical sense, to represent the closure of the theory building—research cycle turns out to be largely ignored in the actual practices of theory building or researching.

This general point may be illustrated in several ways.

Merton’s theory of deviant behavior is a good example of a model focused on outcomes, with the intent of predicting the types and relative frequencies of deviant behaviors in society. My own extension of his typology does exactly the same thing.\(^5\) In both our papers the focus was on outcomes in trying to exhaust the complete range of possible outcomes and in trying to make the types generated mutually exclusive and internally homogeneous. As I pointed out, neither of us used a sophisticated model of social processes to generate the outcome categories of social deviation, and neither of us was disturbed by this failure.\(^6\)

An obvious kind of prediction problem devoid of process knowledge is the forecast of fixed population characteristics from knowledge of characteristics of a sample drawn from that population. In voting forecasts, for example, a sample of the voting cohort is queried as to voting intention and the results projected onto the cohort as a whole to predict the election outcome. An examination of the typical prediction study in the behavioral sciences will reveal this same characteristic structure of the analysis. Parole success, outcomes of marriages, productivity and/or morale of industrial workers, election results, business-cycle fluctuations (especially in the study of consumer intentions), consumer behavior in the marketplace, population shifts, to mention but a few areas where we have made empirically grounded sociological predictions, are all studied in terms of seeking indicators that will forecast outcomes. We are not concerned about the relationships that produced these outcomes.\(^7\)

Let us turn to a comparable look at process analysis when it is used to increase understanding. Homans, for example, has stated and popularized the proposition that the liking of two people for each other is directly related to the frequency of their interaction because frequent interaction permits knowing about individual idiosyncrasies and therefore makes possible mutual adjustments to them.\(^8\) This proposition not only has face validity but seems also to possess great power in permitting broad understanding of a wide range of social phenomena. Yet, if we examine specific social interactions, we are likely to discover that the predictive precision of this law of social interaction is surprisingly low. Examples: The UN-Chinese Armistice Commission has held 500 to 1000 meetings since its inception in 1953, with evidence that the individual negotiators on each side did not, in fact, increase their liking for their counterparts (does this suggest that if the initial contact is hostile, there may be a totally different kind of law of interaction that characterizes subsequent relations [e.g., under the circumstance of hostile contact, increased frequency of contact increases hostility?!]. Sherif’s important “Robbers Cave Experiment” demonstrated that two groups of boys in a camp situation maintained intergroup hostility in spite of daily contacts until the two groups were confronted simultaneously and jointly with a problem that could only be solved through their cooperation.\(^9\) It was only after solving the group-relevant problem that measurable increases in friendliness between individual group members occurred. This suggests that in


\(^6\) Dubin, ibid., pp. 162-163.

\(^7\) Indeed, the basic unconcern with process analysis has led, in the past, to some very imaginative speculation, post hoc, about the interrelationships among particular variables producing given outcomes. For example, it has been asserted that the American male bought a convertible model of an automobile as a mistress surrogate; that the Russian character was formed by swaddling in infancy; that successful marriage mates tended to be like each other; and that the preference for children in the American populace has shifted downward so markedly as to forecast a stationary population by 1970. All of these process speculations were either wrong or questionable. On the other hand, the forecast of the distribution of votes in an election typically increases in accuracy the closer the sample of voting intention is to the date of the election. Here the increase in precision of prediction depends on the patience of the forecaster in waiting until the very last minute to gather data and make his election prediction. He does not need any process knowledge of how the time gap between stated intention and actual behavior affects the latter.

\(^8\) George C. Homans, The Human Group (New York: Harcourt, Brace & World, 1950), pp. 112 and 115. It is notable that the because phrase, the process statement, is separated by three pages from the prediction statement.

\(^9\) Muzafar Sherif et al., Intergroup Conflict and Cooperation: The Robbers Cave Experiment (Norman, Okla.: University of Oklahoma Institute of Group Relations, 1961).
intergroup relations the frequency of interaction may have little or nothing to do with friendliness of the relations between individual members of the two groups. Here the frequency-friendliness proposition breaks down completely in its ability to predict the outcome of the interaction. Finally, we have only to consider the problem of divorce as it relates to frequency of interaction of mates to realize that the frequency-friendliness proposition would produce only mildly successful predictions of marital longevity.

In similar ways, the invasion-succession processes provide a broad base for understanding aspects of urban ecology;¹⁰ the conflict processes for understanding war, union-management relations, and race and ethnic relations;¹¹ the empathic processes for aiding comprehension of face-to-face social interaction;¹² and the decision-making processes for better grasping the bases of purposive social action.¹³ Yet in each of these process analyses there is a remarkable gap between the power of understanding they provide and the precision of the predictions of specific actions to which they give rise.

To summarize up to this point: (1) The prediction problem of behavioral sciences has been focused on reducing the differences between actual outcomes of social behaviors and predicted outcomes. This point of view places little reliance on the analysis of the processes that produce the outcomes being studied. (2) The process problem of social science has generated concern with the analysis of processes of social interaction that contribute to the understanding of why particular kinds of social events take place. The result has been that the level of understanding is broad but relatively imprecise in specifying the probable outcomes in concrete social situations.

This gives rise to two paradoxes. The first is the precision paradox: Why can we achieve precision in prediction without any knowledge of how the predicted outcome was produced? The second is the power paradox: Why can we achieve powerful understanding of social behavior without being able to predict its character in specific situations?


The precision paradox is fascinating. How is it possible to predict an outcome in the form of social behavior without knowing how this outcome was produced? In other words, how can we predict anything without knowing something about the phenomenon being predicted?

Much social science prediction is concerned with predicting the state of a system, usually a social system. It is to this prediction of system states that attention is first turned. By *system state* I mean a condition of the system in which there are persistent values of the variables (units) of the system. Each system state is distinguished from all others by the unique configuration of values for the variables in that state. (See Chapter 7, "System States," for a detailed analysis.)

In dealing with system states, the prediction problem is twofold. We either predict the length of time a given state of a system persists, or we predict the order in which system states succeed each other. We may, of course, also combine these predictions.

In *predicting the persistence of a given system state* we usually employ some broad classificatory scheme that specifies a range of values for system variables as the criteria of a given system state.¹⁴ Thus, in business-cycle analysis, the direction of the curves measuring business behavior is the criterion of the prosperity or depression state of the cycle. Similarly, we distinguish between the states of normalcy and deviancy by using gross indices when examining individual behavior. Or we measure collective attitudes by giving distinctive state designations to those attitudes that cluster around the positive and negative poles of our attitude scales.

This means that very often we can predict the persistence of a system state, or its imminent change, by the degree to which the values of the system variables do or do not approach the boundary conditions of the system's states. For example, we would be constrained to predict a downward shift in the business cycle as being imminent if the summary value of stock market prices approaches its historic high level. Note the characteristics of this prediction: (1) We have some historic knowledge of the boundary conditions of the system states, and (2) we have some current measures of the variables whose values define the system state.

¹⁴The term "value" will be used repeatedly in this book to denote the quantity of a given variable. Thus it is to be distinguished from value as a moral concept as in "American values" or "the Protestant Ethic."
We then literally extrapolate from one to another state of our system.\(^{15}\) Or, given values of the variables that do not approach the boundary conditions of a given state, we would predict the persistence of that state.

It should be clear that in predicting the persistence of a single state of a system we are not bound by any knowledge of how the system operates. All we need to know is enough history of all system states to define their boundary conditions and some current indicators of the variables that define these states. We can then often achieve very precise predictions about the length of time that a given state will persist. Such precision is not based on understanding the dynamics of the system. This kind of precise prediction rests only on accurate description of system states and on the availability of empirical indicators of these states. Indeed, in business-cycle prediction, knowledge that has obvious significance for future economic activity, the basic search has been for empirical indicators whose values lead in time and therefore foreshadow the movement of the entire cycle.

A special case distinct from the prediction of system states is the prediction of the values of one variable from the known values of another variable. Here, instead of predicting system-state persistence or change, we predict the value of one variable. Whether we use some form of direct bivariate analysis or experimental control of multivariate analysis that hold constant individual variables, we use the same operational format as the one just described. For example, for every least square curve describing the relationship between two variables, we predict unknown values of the dependent variable either between known values of the independent variable (by interpolating) or beyond these known values (by extrapolating). The same class of information we need for predicting persistence of system states is also needed for predicting values of individual variables. Furthermore, this is the only class of information needed.

The second analytical problem in dealing with states of a system is to predict the order of succession of system states. Here a logical trick is typically used to give absolute precision in prediction. Consider a system to have only two states. Then, knowing the present state of the system,

\(^{15}\)Implicit in this act of predicting is a law of systems that the late Professor Wirth was wont to characterize in the following aphorism: "If things continue in the future as they have been in the past, then things will be in the future as they were in the past." This is the classic assumption implicit in all extrapolation. It is, of course, a true assumption in many real situations, and consequently can provide the basis for precise prediction without having any knowledge of the internal characteristics of the system, the persistence of whose states is being predicted.

we can predict precisely that if it changes state, it must go into the other state.

Some of the great and respected ideas of sociology are grounded in this logical simplification: mechanical and organic solidarity, gemeinschaft and gesellschaft, folk-urban, sacred-secular, primary and secondary group, in-group and out-group, functional-dysfunctional. If we find a social system in one of these states and it changes state, then we predict with utter confidence the system will go to the second state—e.g., a sacred society that changes will become a secular society.

Obviously, we achieve absolute prediction about the succession of system states if we assume a system has only two states. For example, the inevitability of socialism in the Western world is clear-cut if we see developed socioeconomic systems as having only two states, capitalistic and socialistic, and find them presently in their capitalistic state. The prediction of the inevitability and permanence of socialism is made even more certain if we add the assumption that the oscillation between the states of an economic system is asymmetrical. Thus, the capitalistic state may be succeeded by the socialistic state, but never the other way around (the Chinese critique of Soviet socialism to the contrary notwithstanding). We can then add the second perfect prediction: that if the economic system is in its socialistic state, it can never return to a capitalistic state. But this is like asserting that organic matter has but two states, life and death. Even the folk have the saying, "There is nothing as certain as death and taxes." Their prediction is absolute and certain, at least for the first portion of the saying.

It should again be obvious that precision in prediction, this time of the succession of system states, need not depend upon understanding how the system works. Even if three possible states of a system are postulated and each has equal probability of succeeding the others, we still have a fifty-fifty chance of being right in predicting the succession of states on the basis of guessing alone.

The precision paradox may be summarized as follows: It is possible to achieve high precision in predicting when changes in system states will occur and what states will succeed each other, without possessing knowledge of how the system operates. Furthermore, we can predict individual values of variables without knowing the connection between the forecasting indices and the outcome predicted.

It is the ability to predict accurately, from only incomplete knowledge of a system's functioning, that makes paradoxical our precision in predicting social behavior. Let it be at once clear that I am not decrying this state
of affairs. I find it very comforting and encouraging for the enterprise of social science that we can make precise predictions out of ignorance!

I also see in the precision paradox one of the important reasons why there is both a distinctive technology of applied social science and a distinctive contribution of it to the corpus of the behavioral sciences. Applied social science focuses upon prediction, and insofar as it can get along without understanding, its contribution must be limited, although real and important.16

Power Paradox

The power paradox in social analysis is equally fascinating. Why is it that we can create models17 of social behavior that are powerful in contributing to understanding, without providing, at the same time, precision in prediction?

It will be recalled that I defined understanding as knowledge about the interaction of units (variables) in a system. This understanding may be powerful. For example, we know for the American society that amount of education and lifetime earnings are positively related—the more education, the more total earnings. It is not hard to comprehend why the relationship is positive in a highly technical society. In short, we can understand why education and total earnings are positively associated. If we then made the specific prediction that the lifetime earnings of the graduates of Vassar College will be greater than the total earnings of female high school graduates of Poughkeepsie, N.Y. (site of Vassar), we might make a very imprecise prediction. (Many Vassar girls marry and earn little in their lifetimes, whereas a very high proportion of girls completing high school, but no more, will enter and remain in the labor force with substantial lifetime earnings.)

The disjunction between power of understanding and precision in prediction rests essentially on three factors. (1) The development of a model as a system for comprehending a limited realm of knowledge is necessarily bounded, and hence excludes realms of phenomena. This may have the effect of excluding crucial variables that contribute significantly to an outcome but not to an understanding of the operation of the particular system being analyzed. (2) A model may be a deliberate oversimplification of a range of phenomena that makes for better understanding of the simplified realm but cannot directly generate precise predictions. (3) The model for understanding may focus on broad relationships among the variables composing it and consequently emphasize such a feature as directionality of relationship, which is not itself sufficient to determine precision in prediction.

Each of these three points will be examined in turn.

Limited Domain

An essential characteristic of a powerful model is that it distinguishes a limited phenomenon and focuses analytical attention only upon that realm. The consequence is that for that domain the analytical model makes sense and provides understanding of specific empirical facts that are defined as falling within its scope. In addition, an illuminating insight is contributed to social analysis when we can employ the description of a class of social behavior to tell us what not to expect in that domain. It is no accident, for example, that Cooley named his primary group in focusing analytical attention upon it and left for successors the problem of calling all those group structures not included within his domain secondary groups. The understanding derived from Cooley’s analysis is at least as much an understanding of what is not a characteristic of primary relations as it is an affirmative theory of primary-group behavior.18

Simmel’s famous analysis of the stranger is a powerful model for understanding interpersonal relations. Yet attempts to apply his rules for interaction between strangers to specific situations may generate imprecise predictions about the content or mode of interaction that may ensue. This becomes apparent when the model is applied to interacting strangers who are of different ages, sexes, races, or who do not share a common language, values, or institutional practices. Indeed, even with no such differences separating the strangers, the mere initial failure to assign status to each other would modify the first phases of interaction from what


17The formal analysis of scientific models is presently reaching a climax in an exciting set of developments. An excellent symposium dealing with this issue is H. Freudenthal (ed.), op. cit.

18Cooley’s model was not even very good as a theory of primary-group behavior, for he appears to have been wrong in considering the childhood peer group as the social microcosm that is the principal carrier of adult-like behavior systems.
they would have been had such status assignments been initially possible. Differences between strangers and the failure to make status assignments may be variables excluded from consideration in a theory of stranger relations that make a significant difference in predicting the outcome of stranger interactions.

In some of the areas where process models have been developed it is clear that deliberate exclusions of realms of phenomena are intended. In game theory, for example, the models of two-person nonzero sum games add a cardinal bit of knowledge to understanding by making clear that there may be n-person games, zero-sum games, or both. These domains are not included in the coverage of the models of two-person, nonzero sum games and require distinctive models of their own.

**Simplification**

My second point is that models of process may be deliberately oversimplified in order to clarify understanding. Here the well-established scientist’s trick of holding constant, or controlling, is employed in building the model in order that the resulting simplification may improve understanding. This is a highly essential feature of scientific model building but one most bitterly rejected by social-scientific naturalists with the claim that social phenomena are inherently complex and beyond being understood through simplistic models. There are a number of examples of why this conclusion is at least problematic. Karlsson’s model of information spread is based on the analysis of “a piece of information that is so simple that it is either communicated without change, or not communicated at all.” Admittedly, there may be a few bits of real information that meet this rigorous criterion, but given this simplification, Karlsson was able to develop a model of information diffusion in social groups that contributes to understanding.

Oversimplification may increase understanding without improving predictive precision. Indeed, there may even be an increase in understanding with a corresponding decrease in predictive precision. Simplification in the model may actually reduce precision of prediction, especially under the circumstance where variables excluded from the model are the ones whose values are good forecasters of outcomes even though the relationships of such variables to the processes producing the outcomes are not understood.

**Broad Relationships**

My third point about process models is that they may focus on broad relationships and in consequence may provide imprecise guides for prediction of outcomes. Insofar as we are interested in such broad characteristics of a relationship as directionality or rates of change and critical values of individual variables (e.g., values at the moment when other related variables reach zero or limiting values), we may contribute to understanding without attending to or improving precision of prediction.

Let me illustrate the difference between these two points of view with a simpleminded example. When the productivity of industrial workers is studied in situ, we reach conclusions about the relationship between output and such group characteristics as morale. The studies seem to indicate some positive relationship such that an increase in morale is related to an increase in output. But in situ we have tested this relationship only within very narrow limits. Excluded, for example, is a wide range of low levels of output because, should they be reached in reality, the work organization would take corrective measures. So we really know nothing about how morale and output relate at the low extreme of output. It could very well be that the relationship disappears or becomes negative or curvilinear. Yet should we develop a theory to express this relationship and actually test the process model empirically, we would be contributing to understanding without necessarily improving prediction. There would never be an opportunity to make a prediction at the extreme low values because the organization would have taken corrective action before that point was reached (e.g., fired low-producing workers). This is an instance of how the theoretical model may be very fundamental to understanding without having any practical direct consequences that can become the object of predictions of outcomes.

In a directly analogous fashion the contemporary research on sensory deprivation21 is providing an exciting contribution to understanding the nature of self-identification. We really have nothing to predict about the

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19 An amusing illustration of the consequence of failure to assign status is the true story of Bing Crosby, the singer, who, returning from a camping trip unhaven and ill-kempt, was refused lodging in a hotel until he was able to identify himself unequivocally, upon which the red carpet treatment was accorded him.


state of sensory deprivation because this is neither a customary nor readily encountered real state of the individual. But by studying experimental subjects in a state of sensory deprivation we contribute importantly to an understanding of the stability of their self-images, of some mechanisms for maintaining them, and of the processes of mental life when these images become lost or distorted. Here we have an example of the study of a realm of behavior in which the understanding has surprising consequences not anticipated and not readily employed in predictive statements.

The power paradox may be summarized as follows: A theoretical model that focuses on the analysis of processes of interaction may contribute significantly to understanding. This understanding may be achieved by limiting the system being analyzed, by simplifying its variables and/or the laws of interaction among them, and by focusing on broad relationships among variables. Understanding of process, when achieved, does not necessarily provide the basis for accuracy of prediction about the reality being modeled by the theoretical system.

**Prediction and Process**

These introductory remarks may be considered a footnote to the usual discussions of theory building in social science. I find such a footnote necessary as an additive to incisive analyses like those contained in an important paper by Zetterberg. Professor Zetterberg attacks two central problems: the ordering of propositions and their verification. In setting forth the classifying characteristics of propositions, he makes no distinction between propositions dealing with outcomes and those dealing with process. Consider the following example from Zetterberg, ordering four propositions in a chain.

1. Persons who occupy *central* positions, that is, interact with other group members, tend to obtain a better *knowledge* of their needs and attitudes;
2. Persons who have better *knowledge* of the needs and attitudes of others can more easily issue directives acceptable to others and thus tend to obtain higher *authority*;
3. Persons of higher *authority* tend to receive more *prestige*;
4. Persons with *prestige* become sought-after interaction partners, and thus tend to obtain *central* positions in the group.23

Propositions No. 1 and No. 3 are clearly ones dealing with outcomes. Proposition No. 1 declares that persons who have central positions have better knowledge, and No. 3 asserts that persons with high authority have high prestige. We test both propositions by measuring values on the four outcomes: centrality, knowledge, authority, and prestige, and then relating the values on each pair of outcomes to see if their predicted association holds. (I am not concerned here with the empirical indicators of any of these outcomes, simply assuming that we can secure operational measures of each.)

But now consider propositions No. 2 and No. 4. Both are process propositions. Let me illustrate with proposition No. 2, which claims that possession of better knowledge permits easier issuance of directives, which then results in higher authority. Note the process statement that links the two outcomes (knowledge and authority): "more easily issue directives."24 This is a process statement because it says what goes on, a process taking place, inside the knowledgeable person. We can never measure the ease of issuing directives by using any indices based upon the directives issued (e.g., their number or length or salience for the group).

If we really mean "ease of issuing" as the process statement, then we have to go to the issuer and determine from him his "ease while issuing," and the comparative rank of this ease among all those who ever issue directives (at least in the group under study).

I am sure that in the chain of propositions used by Zetterberg as an illustration, the two process propositions were never intended to be tested empirically. In principle they are testable. But their function, as displayed by Zetterberg, was to link two propositions dealing solely with outcomes. This is an enlightening example to illustrate the twin paradoxes. The outcome propositions used by Zetterberg may have high precision in prediction. His two process propositions may contribute to our power of understanding.

High precision in prediction may be independent of any understanding of the process producing the forecasted outcome. Powerful understanding

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24You will also note that there is a second process statement contained in the proposition, namely, "acceptable to others." Thus, the proposition has two process statements, the one dealing with the knowledgeable person ("more easily issue directives") and the other with his audience ("acceptable to others"). For purposes of analysis we will ignore the second process statement, although it too could be analyzed in a fashion identical with our treatment of the first process statement.
of the process of interaction does not, by itself, guarantee precision in prediction.

Theories give the scientist opportunity to develop understanding of the relations among units upon which he focuses. An elaboration of the understanding aspect of theory building is to be found in Chapter 5, "Laws of Interaction." The theories that catch "'the world' to rationalize, to explain, and to master it," in Popper's words, permit prediction of values of the units of the model or states in which it is to be found. The specification of the uses of theory for prediction will be found in Chapter 6, "Propositions." These two chapters taken together suggest the ways in which the goals of science are realized.

INTERLUDE ONE

So early in the game, let us play it joyously.

—ANON., Welsh Song

Often it seems that there is a fine line separating serious theory from nonsense. That is, of course, if the theory is viewed from the outside without the puckered-brow concentration of the humorless. This brief interlude is designed to encourage the enjoyment of theorizing without its occasional pretentiousness.

NEURO-SOCIOLOGY: THE SCIENCE OF EUMERGENESIS*

Neuro-sociology is the study of eumeromorphic behavior unmediated by cognitive or conscious processes. It may seem strange, but only to those, perhaps, who lack a positivist understanding of science, that one should include nonteleological elements within the purview of sociology. But if one begins with exordium variables, then the roots of behavior must be sought in the somatic realms.

Theology begins, quite rightly, with the question of creatio ex nihilo. Sociology must begin with the question of cognito ex nihilo:¹ does knowledge come out of nowhere, or out of somewhere? And if the latter, where? Common sense, as it so often does, seeks to provide an answer. The man in the street will say, "I feel it in my bones." And he thinks, therefore, that he has reached the seat of knowledge. But the hardheaded


¹One can recognize here a possible modification of the Cartesian formula. Our seventeenth-century philosopher had said, cogito, ergo sum. Our twentieth-century existentialist could say, cognito, ergo sum.
CHAPTER THREE

Units of a Theory:
Initial Distinctions

The locus problem may be described as that of selecting the ultimate subject-matter for inquiry in behavioral science, the attribute space for its description, and the conceptual structure within which hypotheses about it are to be formulated. Quite a number of alternatives present themselves, and have been selected in various inquiries: states of conscious acts, actions (segments of meaningful behavior), roles, persons, personalities, interpersonal relations, groups, classes, institutions, social traits or patterns, societies, and cultures. With respect to each of these there is the associated problem of the unit, that is, of what constitutes the identity of the element selected. Are legal institutions, for example, quite distinct from the institution of the state or part of it, and if so, in what sense of "part"? Are Dr. Jekyll and Mr. Hyde one person or two? Does the Mason-Dixon line divide two societies or only localize certain social patterns?

—Abraham Kaplan, The Conduct of Inquiry

It is most useful to start our analysis of the building blocks of theory with the notion of concept. The idea of a concept has a ring of familiarity about it to almost everyone who has ever professed interest in theory and science. A concept also has many meanings. For that reason alone we all feel comfortable with concepts, however differently we may conceive of their nature.

The purpose of this chapter is to translate the notion of concept to the more colorless and neutral term unit. A concrete meaning will be given to the term unit. We will then examine some important distinctions between paired characteristics of units in order to draw out their consequences for the manner in which we build theories. This chapter is in preparation for Chapter 4 in which are set forth the specific classes of units employed in social theory.
Concept and Unit

Let us start with the relationship between concept and unit. It is necessary in every science to have a way of designating its subject matter. Sciences deal with things. Sciences are focused on aspects of the world perceived by man. For those aspects of this world that constitute the subject matter of a given discipline, the science must have some terms.

The terms designating the things about which a science tries to make sense are its concepts. Kaplan has put the matter succinctly. The important terms of any science are significant because of their semantics, not their syntax; they are not notational, but reach out to the world which gives the science its subject-matter. The meaning of such terms results from a process of conceptualization of the subject-matter. In this process the things studied are classified and analyzed: several things are grouped together and particular things assigned to the several groups to which they belong. . . . The concept of "paranoid," for example, puts into a single class a certain set of persons, and is itself analyzed into such patterns as delusions of persecution, auditory hallucinations, impairment of ego-functions, or the like. Each of these patterns in turn is a classification, grouping together a set of actions, verbal or otherwise as the case may be, and without regard to the actors performing them.¹

In this view, acting as a scientist depends on conceptualizing those things to which attention is given in the scientific inquiry. If the term concept were used only in this sense, we would employ it to mean the things out of which we build theories. But concepts may also mean whole theories or laws of science or even "conceptual frameworks," so dear to the heart of behavioral scientists. This confusion as to meaning of concept has led me to employ the more neutral term unit to designate the things out of which theories are built. This follows Kaplan's usage, as stated in the quotation at the head of this chapter.

Units are not theories. A collection of units that are called the subject matter of a scientific discipline does not constitute the theory of that discipline. It is only when the units are put together into models of the perceived world that theories emerge. This putting together of the units (or concepts) of a discipline into models is what Bergmann suggests gives significance to the particular collection of units with which a scientist chooses to deal. Significance in Bergmann's sense is to be distinguished from truth. Thus,


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A concept is neither true nor false, only propositions are. A concept is neither valid nor invalid, only arguments are. Yet there is a distinction of "good" and "bad" among defined descriptive concepts. To have a name for it I shall say that a concept either is or is not significant. A concept is significant if and only if it occurs, together with others, in statements of lawfulness which we have reason to believe are true. It follows that some concepts are, in an inherently vague sense that cannot and need not be made more precise, "more" significant than others. For instance, a concept that occurs only in one or two tentative and isolated laws is "less" significant than one that occurs in a well-established theory of considerable scope. It follows, furthermore, that what is not significant today may become so tomorrow.²

Bergmann's statement foreshadows our analysis of laws of interaction in Chapter 5. It is sufficient at this point that we understand that units are not by themselves the sufficient components of a theory.

Regarding the units of theory, there is another issue directed at the question of the physical existence of the units employed by theoreticians. Do the units employed in behavioral science "really" exist? Or, indeed, is it necessary that the "reality" of units be the criterion for acceptance or rejection of units employed in a discipline? The so-called "instrumentalist" position on this point has never been fully resolved, as Nagel suggests.

One final comment on the instrumentalist view must be made. It has already been briefly noted that proponents of this view supply no uniform account of the various "scientific objects" (such as electrons or light waves) which are ostensibly postulated by microscopic theories. But the further point can also be made that it is far from clear how, on this view, such "scientific objects" can be said to be physically existing things. For if a theory is just a leading principle—a technique for drawing inferences based upon a method of representing phenomena—terms like "electron" and "light wave" presumably function only as conceptual links in rules of representation and inference. On the face of it, therefore, the meaning of such terms is exhausted by the roles they play in guiding inquiries and ordering the material of observation; and in this perspective the supposition that such terms might refer to physically existing things and processes that are not phenomena in the strict sense seems to be excluded. Proponents of the instrumentalist view have indeed flatly contradicted themselves on this issue.³

Nagel follows this conclusion with an analysis of the realist view of theories and an extended discussion of the criteria of physical reality. He initiates the discussion with the statement that “it is a matter of historical record that, while many distinguished figures in both science and philosophy have adopted as uniquely adequate the characterization of theories as true or false statements [realists], a no less distinguished group of other scientists and philosophers have made a similar claim for the description of theories as instruments of inquiry [instrumentalists].” The last sentence of the discussion concludes, “In brief, the opposition between these views is a conflict over preferred modes of speech.” We will return to this problem with a very simple resolution of the issue in the section of this chapter entitled “Real and Nominal.”

In normal scientific discourse we use phrases like ______ is the antecedent of ______, or ______ varies with _______, or ______ is a function of _______, or if ______, then ______ with a probability of X. In each instance we fill in the pair of blanks with clearly specified things. These things are the units of a theory that are the focus of attention in this and the following chapters.

**Thing Versus Property of Thing**

As we shall see in Chapter 4 when we consider classifying units of a theory in the behavioral sciences, and probably in all sciences, we build our theories about the properties of things rather than about the things themselves. We focus our theories upon selected characteristics of objects rather than upon the objects.

This may at first appear curious because intuitively we may feel that objects are more visible and more readily apprehended than characteristics of them. We can see individual persons, but we have to struggle to invent methods for apprehending their morale. We can walk around and map the boundaries of a city, yet we intrude something we conceptualize as “ecological structure” when examining the relationships between a central city and its suburbs. Why do we go to morale or ecological structure as the analytical focus of attention? These are properties of people and cities, not the things themselves.

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4Ibid., pp. 141-152.
5Ibid., p. 141.
6Ibid., p. 152.

**Units of a Theory: Initial Distinctions**

It seems to me that the answer is a simple one having entirely to do with man’s limited capacities as an observer and his equally limited capacities for recording and retaining many simultaneous observations. We simply are not capable of seeing things whole. Nor is man capable of retaining and recording complex phenomena coming within the range of his sensory fields. It is necessary to acknowledge that man, who builds theories to model his world of observation, has genuine limits on his capacities to grasp complex observations.

Granted such limitations as part of the biology of man, it seems reasonable to conclude that man, the scientist, will solve the problem of his limited capacities by modeling only that which can sensibly fall within his ranges of observation and comprehension. This means he will be selective in what he picks out of his fields of observation to deal with analytically. This in turn means that he will deal with selected concrete or abstract characteristics of things rather than with things as wholes.

We are alleging, then, that the characteristic concern with properties of things rather than with things themselves as the units of theories is a consequence of man’s biology rather than the nature of things. Once we accept this simple assumption, we are freed of the hoary issue of dealing with the essence of things. We simply admit that we do not know what things “really” are or are “in essence.” Nor are we any longer interested in this issue. The more viable assertion, at least for the scientist, is to declare that it is a mere inventory problem to add up all the properties of things at any given time, for both man’s imagination and his skills in extending observations must inevitably add to the inventory in the future. We have only to note what has happened in the subatomic jungle to realize that with more than thirty fundamental particles of matter already experimentally demonstrated, and with more undoubtedly still to come, it seems scarcely meaningful to say that matter “in essence” is the sum of its known parts today or its even more numerous parts in the year 2000.

Probably the most important consequence of dealing with properties of things as the units of theory is the release of imagination that it affords. The moment we can divide a thing into two or more of its properties, it then becomes possible, at least imaginatively, to ascribe to it still other properties. This release of imagination is enhanced when we look upon the properties of a unit as providing opportunities to test relationships with other properties, and not merely as a new tally in the inventory of the unit’s totality.

You will note that I have not made any assertion about the reality of any ascribed properties of a thing. It is not necessary. Indeed, this is one of the fundamental starting points for any scientist. He starts by wonder-
Theory Building

ing about the properties of things and may be quite imaginative in ascribing particular properties to particular things. This is one of the sources of creative theory. Pasteur, after all, was ridiculed by his scientific peers almost universally because he imagined that a then unknown thing called a microbe could cause a specific disease. Chen Ning Yang and Tsung-Dao Lee won their Nobel Prize in 1957 because they were imaginative enough to think of electrons as being left-handed rather than right-handed in the direction of their orbits.

It should also be clear that I have not asserted anything about the operational character of the properties of things that are the units of a scientific theory. The issue of operationalism comes much later in the theory building-testing cycle. Specifically, much will be made of operationalism in Chapter 9, "Empirical Indicators." There we will give full credit for all that is usefully claimed for operationalism, and simply ignore those claims that are irrelevant.

Unit Versus Event

For purposes of any scientific theory we need to distinguish between a unit and an event. The distinction rests on the question of number. An event happens only once; any particular event has a population of exactly one. Any time we encounter a situation where the possible population is exactly one, we are dealing with an event.

It follows then, that a unit of a theory must ultimately be able to count two or more entries in any tabular cell for which the unit provides one column or row designation. In a specific situation under investigation the population may in fact be zero, but over many samples of such situations the investigator must postulate that the population exceeds one.

The reason for distinguishing between a unit and an event is twofold: (1) We want to distinguish certain types of historical explanation from theory, and (2) we want to dispose of the nagging problem of the uniqueness of all things at each point in time.

An historical explanation of a unique event that seeks out the antecedent causes of this event is not a theory. Such an explanation may be quite accurate and fully supported by available facts. The explanation may even have long-term currency among experts, being accepted as correct for many years. It is, nevertheless, an explanation of something that occurred only once. Its antecedents and their modes of combinations can only explain that one event, no more. Confronted with another singular event, the historian must marshal new explanations, doing this endlessly for each new event. What he has learned about the antecedents of one event are not applicable in explaining another event.

Theory, on the other hand, is concerned with modeling the processes and outcomes of particular units interacting in systems, whenever these systems exist and under all conditions of their existence. For example, should our historian shift his problem from explaining the origins of the American Civil War to a search for the origins of war, then he becomes a theorist and his theory will contain as one of its units, war as a social relationship. War becomes a unit of this theory precisely because attention is now focused on a property of groups for which there is a population of more than one (all the wars of human societies or all the wars of the Western world or all the wars of the United States). Any predictions about the group property "war" must hold for all members of groups characterized by this property.  

It should be clear, then, that much of the time social scientists and historians are theorists, actively testing their theories in the empirical world. But many historians and social scientists who work with events are not theorists testing theoretical models, even though they offer as their products cogent and valid explanations of the events with which they deal.

The contrast between unit of a theory and event is crucial in distinguishing two empirical positions that oppose each other on philosophical grounds. Briefly stated, the conflict may be summarized in the following terms: One school holds that all points in time are events. At the moment you read this you are one person, but by the time you get to the end of this chapter or even of this paragraph, you are another person. Obviously, you have aged, tired, become hungrier, and so on, all of which are measurable properties of you and which therefore are empirically available. From this point of view, the scientist is constrained to claim that he is describing chains of events. At best, scientific generalization is limited to describing those chains of events that seem to be like each other. But the dilemma is that the events that make up the chains are, by definition, unique, which then raises serious questions about the identity among sequential chains that link such events.

The following conclusion by Brodbeck agrees with this analysis. "There is no such thing as 'historical' explanation, only the explanation of historical events." May Brodbeck, "Explanation, Prediction, and 'Imperfect' Knowledge." in H. Feigl and G. Maxwell (eds.), Scientific Explanation, Space, and Time, Minnesota Studies in the Philosophy of Science, vol. 3 (Minneapolis, Minn.: University of Minnesota Press, 1962), p. 254. See also Kaplan, op cit., pp. 367ff.
Among its more moderate proponents, the opposing school concedes the event character of many properties of things. But the argument goes on to conclude that there are also properties of things that are independent of events. It is to this second class of properties that scientific attention is turned, and they become the units of scientific theories. This book is written from the standpoint of this second position.

It should be clear that I am not here identifying event with the property "time." We can, for example, employ time as a unit in a theory. Such an assertion as "The longer two groups are in contact, the greater will be the amount of cultural exchange between them" employs time as a unit in a theory of intergroup relations. A simple empirical test of the assertion (I will later call this a prediction) is to plot on one axis of a coordinate system the amount of time pairs of social groups have been in contact with each other, and on the second axis the sum of the cultural items originating in each member of the pair that are now found in the other. If the assertion is accurate, then there ought to be a correlation significantly greater than zero, and the slope of the line describing the relationship should be positive.

Attribute and Variable

Units of a theory may be either attributes or variables. This distinction turns out to be exceedingly important for the structure of tests used when a theory is confronted with empirical data. It is for this reason that the notions of attribute and variable will be elaborated in some detail.

An attribute is a property of a thing distinguished by the quality of being present. The thing always has this quality if the attribute is a property of the thing. All things having a given attribute property constitute a set of identities on that attribute property. All other things are in a set identified by the lack of the given attribute property. For example, social groups are defined as possessing the property of membership interaction; failure to possess this property will lead to a given collectivity being classified as a nongroup (e.g., an aggregate such as an occupational class).

A variable is a property of a thing that may be present in degree. There may be some of the property present or a lot of it. We may express the degree of presence of the variable property of a thing by either a cardinal or an ordinal scale. What is significant when we employ a vari-

able unit in a theory is that our attention becomes focused upon the amount or degree to which this property is present in the thing.

Let us now turn to the problem of the structure of a theory as it relates to the employment of attribute and variable units or combinations of both.

When a theory employs only attribute units, the minimum formulation of a relationship between two units in order to constitute a theoretical model is a $2 \times 2$ table of the form shown in Table 3-1. The importance of recognizing the $2 \times 2$ table as the complete formulation of a relationship between two attribute units is the following: Cell #1 has values on both attributes. This, obviously, is an important cell expressing the relationship between $A$ and $B$. In social research we are often so optimistic that we are inclined to build models that imply, if not state, predictions like "All As are Bs" (e.g., delinquent children come from broken homes, working-class members vote Democratic). Our optimism is, of course, never realized, for there are always some As that are not also Bs, some Bs that are not also As, and if we look hard enough at the empirical domain we are modeling, we may even find some not-As that are not-Bs.8

If we really mean "All As are Bs," we may also mean "All not-As are not-Bs" (cell #4), and we may choose among several alternatives for expressing the relationships in cells #2 and #3. We may even specify the proportions with which As and Bs are associated in the four cells as follows: "90 percent of all As are Bs; 10 percent of As are not-Bs," and so on. Even in such instances, however, it is clear that the total set of any theoretical predictions made about the relationship between two attribute units must be made for all four cells of the table of relationships.

Let us now focus our attention on cell #1 of Table 3-1. This cell tells

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8 If optimism is not enough to encourage us to neglect cells #2, #3, and #4, we may employ research tricks to secure the same result, e.g., because we look for cases where there are values on both $A$ and $B$, we would not include in our samples instances where both are absent and, if we find such instances, we are likely to "purify" the sample by casting them out. Thus, a person who refuses to respond to any questions in a survey research study may be a cell #4 case, although we do not know this for certain. We usually ignore such instances, after piously reporting their total number.
us that attribute \( A \) and \( B \) are simultaneously present. Suppose now that \( A \) and \( B \) are both variable units. This means that each may be measured on either an ordinal or an interval scale. If both are measured on an ordinal scale, then the standard research design is for the purpose of testing some theoretical prediction about the relationship between the rankings of both variables. If both variables are measured on an interval scale, then we make a test of some predicted relationship between the quantities of each. Finally, if one is measured on an ordinal scale and the other on an interval scale, we test the relationship between the ranking on one variable and the quantity on the other.

Note carefully that when we employ only variable units in a theory we are focusing attention on only a single cell of the basic 2 \( \times \) 2 table, as represented in Figure 3-1. There is nothing in the theory that says anything about the other three cells of the table. Nor is it then appropriate to examine empirical data that would fall into the other three cells, for such data would have no relevance for our theory.

The point just made should not be confused with the situation portrayed in Figure 3-2. Here we have data displayed in a cell \#1 situation where the variables can be each measured on an ordinal or an interval scale. You will note that there are some cases that fall at the zero value of \( A \), some at the zero value of \( B \), and one that has a zero value on both scales. These three classes are not instances of cell \#2, \#3, \#4 entries. For example, the three cases of zero values on \( A \) where there are values on \( B \) are not cell \#2 entries, which would be a \( B \), not-\( A \) cell. The zero values on \( A \) are real values of \( A \) and should not be confused with the not-\( A \) category.

Another limitation to analysis is revealed when we employ a combination of attribute and variable units in a theory. This usually occurs when we draw some sort of broad attribute distinction and then ask, "How does the distribution of a given variable unit differ between these two attribute units?" The classical illustration of this theoretical problem is the controlled experiment in which one attribute unit is labeled experimental group and the other control group. These two groups are distinguished by the fact that one has the property "subject to some sort of experimental treatment" whereas the other has the property "excluded from the experimental treatment." We then seek to measure some variable characteristic of both groups in order to determine whether or not the experimental treatment makes a difference. This, of course, is just one illustration of theory employing attribute and variable units. In social science, contrasting sexes, social classes, urban-rural background, authoritarian-democratic atmosphere, and so on, have an identical structural format.

In terms now of our 2 \( \times \) 2 table, this combination of attribute and variable units involves comparing the internal distribution of the population in cell \#1 with the internal distribution of the population in cell \#4. The situation is illustrated in Figure 3-3. You will note immediately that the structure of the comparison we are making is to contrast the distribution of the measured variable in cell \#1 with the distribution of the variable in cell \#4. The more customary way of presenting the comparison is to place the distributions (or statistics like means and standard deviations representing the distributions) in the same column, as shown in Figure 3-4. This, of course, obscures the fact that we are really comparing results in cell \#1 with those in cell \#4.

The logic of this design is impeccable. It insures that the special combination of "experimental-treatment" (\( A-B \)) is contrasted with "control-no treatment" (\( \text{not-}A-\text{not-}B \)). The design is intended to insure that there is complete independence of each combination of attributes from the other combination.
We may now summarize the consequences of employing attribute and variable units in building a theory. (1) When two attribute units are employed, the structure of the theory expressing their relationship leads to predictions about the empirical distribution of a sample population among all four cells of a $2 \times 2$ table. (2) When two variable units are employed in a theory, the structure of the theory expressing their relationship leads to predictions about the direction and degree of relationship between the variables only in cell #1 of a $2 \times 2$ table. (3) Where units employed in a theory are a mixture of attribute and variable units, the structure of the theory expressing their relationship leads to comparisons between cells #1 and #4 of a $2 \times 2$ table regarding the dissimilarity of the distribution of the variable in those two cells.

The point needs to be given strong emphasis. The kinds of units employed in building a theory, whether attribute or variable, make a difference in the structure of the theory, the kinds of predictions it generates, and the extensiveness of the tests that can be made of it.

This distinction between attribute and variable units as they are related to the structure of a theory being tested departs radically from the usual treatment of the difference. It is common to consider attribute units as more primitive than variable units. Whenever available, variables are, therefore, preferred as being more exact and being more nearly attuned to a rigorous scientific discipline. In short, variable units are considered to have greater precision than attribute units. I am asserting that the problems of rigor and exactness are issues of measurement that apply equally to both attribute and variable units. What distinguishes the two is their function in a theory and its testing, not their relative susceptibility to satisfying the criteria of measurement.

It should be recognized that a variable measure can always be converted to an attribute measure by turning the metric into class intervals. This is commonly done by using a mean or median to dichotomize a

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distribution of scores, or by employing other criteria to convert a continuous distribution into contiguous classes. However, attributes are seldom readily converted into variable measures. This, of course, argues for the practical utility of variable measures since they may be employed with greater versatility than attribute measures of the properties of units.

Lord Kelvin's statement made toward the close of the nineteenth century reminds us of the older view expressing preference for variable units.

When you can measure what you are speaking about and express it in numbers, you know something about it; when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind.  

Let it be clearly understood that I am not asserting a preference for either variable or attribute units in theory building. I do not join with Lord Kelvin and his many followers down to the present day who claim dial readings to be the goal of empirical description. Nor do I prefer more the humanistic position that the logic of human thinking is grounded in attribute distinctions that must perforce become the methodological cornerstone of theories in the social sciences. My position is clearly that both attribute and variable units have their place in theory building. They are different places, however, and the working scientist is well advised to know what they are.

Real and Nominal

Philosophers distinguish between real and nominal definitions, and this contrast carries through much of the discussion in the philosophy of science. The contrast is expressed in contemporary literature on the philosophy of science as the distinction between a realist and an instrumentalist position. Logically, it would appear that units of a theory could also be placed into the real and nominal classes. This conclusion seems well taken and will be accepted as a starting point here.

We will agree that units of things, as properties of things, can be called real units or nominal units. This distinction, however, rests only on the ability of the scientist ultimately to secure empirical indicators of the units he employs in his theories at the points where tests are made of the theories.  

Where there is some confidence that such empirical indicators are available or can be invented (i.e., instruments can be developed to produce empirically ascertainable traces), the unit of a theory for which the empirical indicator stands will be called a real unit. Where empirical indicators are not considered to be available to stand for a unit, it will be designated a nominal unit.

The distinction between a real and a nominal unit rests solely upon the probability of finding an empirical indicator for the unit. This means that every nominal unit has the potentiality of being converted into a real unit with progress in the technologies of developing empirical indicators. This point is a crucial one for the working scientist and probably is one of the important features of his outlook that distinguishes him from the philosopher of science. The working scientist is quite willing to gamble on finding or inventing empirical indicators for any units that he finds interesting enough to build into his theories. The philosopher of science may feel constrained by his beliefs about the essential and limited reality of things to hold that there is an immutable category of nominal units. The philosopher of science would probably never give a second thought to ink blots, but Dr. Rorschach did, much to the enrichment of the technologies of projective testing and to the increase of knowledge about the human psyche.

It has been one of the contentions of the extreme operationalists that only real units are properly employed in theory building. The reasoning is that unless one can ultimately produce a measurement operation to stand for each unit of a theory, the theory is untestable and therefore only entitled, at best, to the status of a theology.

This argument may be countered in a very simple way. The working scientist says that at some point, when confronting the empirical world, he needs indicators for the things he finds "out there." But, and this is critical, if he cranks up his curiosity only with those things for which he already has empirical indicators, then (1) he probably will never attempt to discover new empirical indicators (as he cannot think of looking for new things if his only tools of imagining are the representations of what he knows already), and (2) he probably will devote a majority of his research to wholly trivial problems. Consequently, when he builds the theories he will want to test, he will be perfectly willing to include in the


11The humanistic position is particularly well revealed in Max Weber, The Methodology of Social Science (New York: Free Press, 1949), where it is given a formal expression in what is identified as the ideal-type method.

12Empirical indicators are discussed in Chapter 9.
theories nominal units, if they prove to be useful. The test of useful is simply whether or not the new theories give him something new or different to look for in the empirical world.

Now in order to crank up the scientific imagination in this way we have to pay a price. The price is that we will not be able to measure some parts of our theories because there are nominal units involved in them. This is not the only reason why a whole theoretical model is never completely tested by empirical research; it is an important one, however. This cost is a genuine one, for it means that portions of many theories cannot be tested.

I think, however, that the profits that derive from investment in nominal units to build theories far outweigh this cost. The profit lies in the imaginative extension of the domains of scientific curiosity, in ultimately adding to knowledge by increasing the realms of the known and the knowable, and in pointing out more accurately the realms of the unknown.

Such units of social science theories as id, ego, anomic, tele, syntality, conflict, power, charisma, subjective probability, maximization, culture, and society have played important roles in the development of scientific theories in psychology, sociology, political science, economics, and anthropology. Each of these is a nominal unit denoting either a presumed thing or a presumed process characterizing social life. The unit mass is a nominal unit of physics that is central to theories in that science, and I am certain that each scientific discipline has its comparable nominal units. The point is that working scientists could not do without nominal units.

The issue for the working researcher is not to insist that theories contain only real units. The issue is rather to insist that the structure of theories be clearly understood so that the functions of nominal units in them will be readily recognized. It is true that empirical tests are made only of real units and their interactions. It is equally true that whole theories often contain nominal units that, although presently beyond empirical reach, are nevertheless essential to the theory. Their essentiality rests on the fact that understanding of the real units and their behaviors is increased when the nominal units are included in the theory.

The problem of nominal and real units will arise again when we examine the propositions and hypotheses of a theory in Chapters 8 and 10 and when we turn to empirical indicators in Chapter 9. For the purposes of the present discussion it is sufficient to assert that we will make a place for both nominal and real units in building theories.13

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13It should be noted that a theory built solely of nominal units can be accorded only the status of a theology, not that of a scientific theory. The two differ, however, only in the kinds of units each contains and not in logic of construction or coherence of structure.
an accident of the research process. He then said, in effect, there is some $X$ here that is somehow connected with what appears in the field of the microscope. When his attention turned to explication this $X$, we were given the gift of penicillin. The point is, of course, that the admission of a unit as a primitive unit into a theory immediately cries out for translation into a sophisticated unit. But this is done only by starting with a primitive unit.

The employment of primitive units in building a new theory occurs in one of the generalizing stages of the scientific enterprise. This happens as follows. Suppose the scientist is confronted with several findings that operationally cannot be quite the same things. That is, the operations by which the empirical indicators were measured were not identical. The scientist then looks at these findings and in effect asks, "Is there anything in common among these findings? Do these findings somehow or other have a common core because they are really empirical indicators of the same thing or unit?" The answer to this question may simply be a name applied to this thing, an identifying label that serves to tag it but not to define it. Once this tagging is done, the scientist is then in a position to focus attention on the tagged thing and bring it into a new theory as a nominal or a real unit.

A beautiful example of using primitive units in theory building is revealed any time factor analysis is employed in research. The fundamental characteristic of factor analysis as a statistical technique is that it can take an assortment of empirical indicators (like tests, for example) and objectively demonstrate which indicators sort together with which others, and what is the minimum number of distinctive groups into which all used indicators can be sorted. The outcome of this objective sorting process is to produce factors that are simply numbered or lettered or tagged with a name. Either number or letter will serve just as well, but the scientist immediately begins to examine those empirical indicators that load heavily on a given factor and tries to generalize a descriptive term that will denote his guess as to what those empirical indicators have in common. This generalized descriptive term then becomes a primitive unit of a new theory and undergoes whatever transformations are necessary to convert it into a sophisticated unit in order that the new theory may be built.\textsuperscript{14}

We may now summarize what appears to be an essential difference between a philosopher of science and a working scientist in their treat-ment of the primitive unit. The scientist often starts with empirical observations from which he generalizes a primitive unit. The philosopher of science starts in his mind with a primitive unit. Both proceed beyond this point in identical manners to build a theory by incorporating the primitive unit or converting it into a sophisticated one. The difference, then, is whether one starts with the empirical world to generate a primitive unit or within the mind with an imagined primitive unit. I think it makes a real difference in what kind of theory emerges, even though the processes of theory building beyond the state of designating a primitive unit is the same for both philosopher and scientist.

Collective and Member

One final general distinction needs to be kept in mind. It is the difference between a class considered as a unit and the individual members of that class being treated as units. In mathematical terms this is the distinction we draw between a set and elements composing the set. The purpose of making this distinction is simple. We need some way to designate many things sharing at least one common characteristic and to be able to treat them as a unit in a theory. Under other circumstances we may want to treat one or more of the individual things as a unit by itself, independently by the fact that it shares membership in some collective unit by virtue of having at least one characteristic in common with all other members.

For this distinction between set and element we will employ the somewhat more graphic labels popularized by Professor Paul F. Lazarsfeld. He calls the set a \textit{collective} and the element a \textit{member}.\textsuperscript{15}

There is an exceedingly practical consequence of making the distinction between collective and member. It calls the theorist-researcher's attention to the fact that there may be serious logical dangers in building theories that deal simultaneously with collective and member units. This danger is not true of all theories, but it does exist for some, and where the logical impasse is possible, the difference between collective and member will aid in showing it up. For example, Robinson has pointed out the logical dangers of using ecological correlations based on collective units.


to predict the behaviors of members of these same collective units. He demonstrated that correlations based upon measures of a collective that give rise to what he calls ecological correlations have different values than the correlations based upon measures of the members composing the collectives. He concluded,

The relation between ecological and individual correlations ... provides a definite answer to whether ecological correlations can validly be used as substitutes for individual correlations. They cannot. 16

The collective-member distinction really underlies the intellectual issue called reductionism, which seems such a hardy perennial in the social sciences. Largely for imperialistic reasons each social-science discipline seeks to keep its theory from being "debased" to a different level of explanation. It is especially notable that the disciplines seem to have a fear that they can ultimately be shown to be mere branches of psychology and that all social-science theory rests upon psychological theory. Durkheim, for example, raised this battle cry for sociology and made it an article of faith that a sociologist must swear to use only "social facts" in doing sociology. 17

Whatever intellectual imperialistic purposes such admonitions may serve (and they are useful as tools of academic imperialism), the ranting against reductionism contributes nothing to the issue of whether or not there is some linkage among the various levels of analysis. We can see the possibility that each member of a collective may itself be a collective for its interior member units. Thus, one can analytically go from society to group to person to organs to cells to atoms. What becomes a critical question is how these levels of analysis link with each other between adjacent levels and how they link up between levels separated by one or more intervening ones. I will attempt a straightforward answer to this question at the end of Chapter 5, "Laws of Interaction" and in Chapter 6, "Boundaries." The distinction between collective and member turns out to be useful in sorting out the levels of units that enter into a theory.


ployed relate to the things he observes. Chao is most accurate in the heading quotation when he concludes that for the scientist, "my thing can be any thing." This unconstrained willingness to admit all possible units into a scientific model provides the widest range of opportunities for theory building.

There would be utter chaos if no order existed among the possible units available for developing a model. The probability of replication of research would be materially lowered as well. Fortunately, it is possible to classify the units employed in behavioral theory into a limited set of types and to then examine the manner in which mixed types may be incorporated into the same model.

Initially in this chapter a typology of units of theories is developed that has as one of its main purposes to reach conclusions about the kinds of units that can and cannot go together in the same theoretical model. Attention turns next to a consideration of descriptive research and the logical and statistical technologies available for the discovery of new units to be employed in theories. The discussion then takes up the question of parsimony in the number of units to be employed in a given model and how to apply statistical tests of parsimony. Finally a few loose ends are tucked into the end of the chapter to bring us back to the big problem highlighted in the opening quotation from Ashby, that the units of a theoretical model constitute "a list nominated by the observer."

Types of Units (EARSS)

The previous chapter started with the assertion that the units of a theory are properties of things rather than the things themselves. We are now in a position to undertake a classification of such properties. This is a classification of all sophisticated units, with only those further limitations as noted that apply to summative kinds of units.

I will label and describe five types of units for which the mis-spelling of urs (EARSS) provides a useful mnemonic device: enumerative unit (E), associative unit (A), relational unit (R), statistical unit (S), and summative unit (S).

Enumerative Unit (E)

An enumerative unit is a property characteristic of a thing in all its conditions. That is, regardless of the condition of the thing that can be observed or imagined, it will always have that property. We mean by the notion of "condition" all the states under which the thing will be found. In Chapter 7 specific consideration will be given to system states as a feature of theories. At this point we can work with the equivalence of condition and system state without further specification.

The universality with which all members of the set of an enumerative unit possess the property holds for either attribute or variable enumerative units. Where this property is an attribute, then it is always present. Indeed, by its very presence, it can become the shorthand identifying tag for the entire thing. Where the enumerative unit is a variable, then a count among all the sample members of the thing determines how much of the enumerative unit each possesses. It is this counting process associated with an enumerative unit that gives rise to its name. Examples of enumerative units are shown in Table 4-1.

For attribute enumerative units the unit designation may become the basic criterion for sorting out the sample composed of such units. Thus, we may seek a sample of social groups with closed boundaries or with limited purposes or with both. We may choose a sample of males or a sample of persons with strong motivation to conform to social expectations. In each instance, all things accepted into the sample must possess the attribute or attributes being counted. In a similar way, when we use variable enumerative units it will be noticed that we count how much of the unit is a property of the thing. We determine how much cohesion the group exhibits (and if the answer is none, then it is not a group) or how many members compose it. We measure how old a person is or the number of acts in which he has engaged during a given unit of time.

The enumerative unit is universal—the characteristic property is always present in the thing and is counted in any sample of the things under

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<tr>
<th>Attributes</th>
<th>Social Group</th>
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<td>Variables</td>
<td>Social Group</td>
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investigation. This universality is a significant feature of enumerative units for it serves to distinguish this type of unit from an associative (A) unit. There can never be a zero value for or a sample member who does not exhibit the characteristic of an enumerative unit. There can be for associative units. Thus, education is an associative unit for a thing labeled person because when measured by formal education, some persons may have none.

There are two complementary features, then, of enumerative units. (1) The property is universally present in all states of the thing. (2) This means that any unit for which there is a zero value or an absent condition is not an enumerative unit.

**Associative Unit (A)**

An associative unit is a property characteristic of a thing in only some of its conditions. In all respects save one it is identical to an enumerative unit. The one difference is that there is a real zero or absent value for associative units.

The existence of a zero value for a unit is a critical feature of that unit. There are consequences, for example, for measurements that relate to the possibility of a zero value existing for a unit. There are other kinds of consequences in which we have both positive and negative values of the unit. Does the value of the unit pass through zero in going from positive to negative values, or vice versa? Or looked at another way, if there is the possibility of a zero value of the unit, then do we also entertain the possibility that there are negative values as well? None of these issues are germane to enumerative units. These issues are very important, however, to associative units and the kinds of models in which they are employed.

The convention of calling these units associative units has been adopted because it seems to describe adequately the fact that such units are characteristic properties of some but not all states of the thing. They are associated, in other words, with the thing partially and under limited conditions.

Table 4-2 illustrates associative units. It should be understood that the illustrations used here and with the discussion of the other types of units are by no means exhaustive.

For each of the illustrative associative units shown in the table, there is a possibility that the value of the unit may be zero or negative, or both, in one or more states of the thing. There is the possibility, for example, that a social group operates at least some of the time without reference to myths characteristic of it. A person may exhibit positive, negative, or no affect in a given situation or action, or we may count the individual's skill in doing productive work as ranging from high skill to no skill (the zero value in this instance). We might even find a metric for measuring affective response, in which case we could consider this a variable associative unit, ranging in values from strong positive through zero (neutral) to strong negative. When we examine the variable associative units of Table 4-2, we can see that a group defined as a governmental unit may either have or have not a bonded indebtedness, the exact amount of which may be measured on a dollar scale. We may also measure a group’s stability on an interval or ordinal scale (by counting membership turnover, for example) to find whether it is at all stable and, if so, to what degree. Finally, we may use years of formal schooling to measure an individual’s education, with none being the zero point on the scale, and do the same thing for a person’s income, passing through a zero point to negative values if we refine the associative unit to call it net income.

All these illustrative associative units have zero values, and some have negative values. This point will become especially pertinent when we consider any whole theory. Whenever we employ associative units in a theory, we may expect that there will be some states of the system being modeled in which these associative units will have zero values or even go to negative values.

The zero value becomes important for two reasons. (1) It first of all means that any predictions we make about the system must cover those states of the system in which the incorporated associative units go to zero or become negative. Thus, when we employ associative units, we automatically force our predictions about the theoretical system to include states in which these units really go to zero or take on negative values.
This becomes one test of the completeness of the predictions generated by the theory. (2) The empirical-description side of the predictions generated by the theory. The empirical-description side of the predictions generated by the theory. The empirical-description side of the predictions generated by the theory. The empirical-description side of the predictions generated by the theory. The empirical-description side of the predictions generated by the theory. The empirical-description side of the predictions generated by the theory. Then we would probably build a theory completely excluding this property, unless we had one or more additional empirical situations to describe in which the property had a nonzero value. Thus, associative units may be excluded from a theory simply because we have poor description of the empirical world, and happened, by chance, to pick situations to describe in which the excluded associative unit had a zero value. Indeed, one of the ways in which we formally admit this kind of error is to assign the title intervening variable to such an associative unit when we discover some positive or negative values for it later on. A more extended treatment of intervening variable appears later in this chapter, in the discussion of parsimony in the number of units employed in a theory.

To summarize, there is one outstanding feature of an associative unit: it must be able to have a zero, or nonpresent, value. Enumerative and associative units have been distinguished on the basis of the zero value assignable to the latter. Attention now turns to consider three additional types of units whose definition moves into entirely new dimensions.

**Relational Unit (R)**

A relational unit is a property characteristic of a thing that can be determined only by the relation among properties. These relations may be of two general sorts. The first is the relation based on interaction among properties, as we might consider a relationship to be a proper one when a superior. The second form of relation is based on the combination of properties, as we examine the sex ratio (ratio of males to females) of a population group.

A relational unit, then, identifies a property of a thing by calling attention to the fact that the property is derivable from at least two other properties. For example, a subordinate and a superior, when they interact, have as an outcome one property called subordination. The properties of being a superior and of being a subordinate, when taken together, produce the property of a relationship called subordination. Similarly, the property "male," and the property "female" (when they combine, not interact!) produce the property "sex ratio."

It is apparent that a relational unit is more complex than an enumerative or an associative one. Its very complexity is a distinct advantage in building theories about social phenomena, which tend to be complex. Employment of a relational unit really permits us to make one term stand for two properties of a thing. At the same time we sometimes are prone to lose sight of this and reify the relational unit, obscuring the fact that it is not itself a property of a thing but a property of two or more properties of things. For example, in sociology we may speak of an anomic individual and assume that the person has the property of anomic. Actually, of course, we mean that the attitudes held by the person toward norms of a social group combine or interact in a way that is characterized as anomic—the interaction of personal attitudes and social norms produces the attitude of normlessness held by the person.

Since several examples have been used to describe relational units, no illustrative table will be employed. Instead, I will underscore the fact that such units are commonly employed in the behavioral sciences without recognition of their characteristic form. We will employ a unit like ethnocentrism as though it were a property of a group when what we mean is that it is the consequence of the ratio of group members' preference for fellow members over other-group members. We analyze sibling rivalry and tend to forget that the term designates a condition of relations between siblings as a consequence of the relations of each to his parents. We use the term status without recognizing that it arises only in the comparison among two or more individuals and that its achievement or ascription involves an interaction between an evaluator, a standard, and the subject of evaluation. We discourse about elites or power elites and sometimes lose sight of the fact that a nonelite, and relations with it, are necessary to make sense out of the property "elite."

Relational units are defined as a property of two or more properties of things. Note that both properties and things can be plural. In the example of sibling rivalry, the property of the sibling relationship and the relation of each child to each parent are all summed up in the term, giving us plural properties (child-child relationship, parent-child relationship) and plural things, children and parents. The price we pay for having available single relational units to sum up two or more properties of things is that we are likely to ignore the summing-up feature of the unit. This may be a heavy cost to the theorist-researcher, as his theory may be incomplete and his empirical indicators inaccurate. This, of course, does not argue against the use of relational units in building theories. Indeed, I am claiming they are exceptionally useful. It should be recognized, however, that they may be misused.

In the behavioral sciences we are particularly addicted to the use of relational units in building theory because such units cover so much with
so little effort. It is well to be clear in understanding the complex character of such units when they are employed. If we are not clear, we can often pass off tautologies for conclusions, viz., if we assert that a frontier society typically has a very high sex ratio (ratio of males to females) and is a characteristically male society, we have said the same thing twice under the guise of generalizing.¹

Statistical Unit (S)

A statistical unit is a property of a thing that summarizes the distribution of that property in the thing. A statistical unit derives its name from the fact that we have adopted statistical terminology dealing with measures of central tendency or of dispersion as the nomenclature for statistical units. For example, the mean or median income in a population group may be employed as the unit of study, and this measure may be taken to stand for income distribution in the group as a whole. Or we might designate a group being studied as heterogeneous on some property and proceed to contrast it with a homogeneous group on the same property, thus taking into account the differential dispersion of the property in the two groups.

In general we can distinguish three classes of statistical units: (1) units summarizing a central tendency in the distribution of a property; (2) units summarizing the dispersion of a property; and (3) units locating things by their relative position in a distribution of a property. Median income, as noted, may be taken to stand for the income distribution of an entire group and used as an analytical unit in theories about income, its distribution, and its relations to other social phenomena. Dispersion of a property may be summarized in a statistical unit that stands for the property in the group as a whole, as when a population group is designated as culturally unitary or culturally diverse, or an individual as moody or stable. Finally, we often use statistical units to designate relative position, employing terms like high status or underachiever to denote a property of an individual or middle class and underdeveloped to denote a property of a group.

In employing statistical units for analytical purposes, we have to recognize and be familiar with the underlying statistical reasoning that gives particular meaning to each of the three classes of statistical units. When we employ any notion of central tendency, we assume that a property can be best summarized by its most common value (mode) or its middle value (median) or its average value (mean). When we use a central-tendency measure as a unit for describing a property, we become very conscious of its limitations in describing the dispersion feature of the property.

When dispersion-type statistical units are used, we give up the opportunity to express the central tendency in the population being measured. For example, if we were to take income range to measure the homogeneity or heterogeneity of residents of suburbs, with no further specification of statistical unit, we would be uncertain regarding the most representative incomes in the suburbs being studied.

When ranking or relative-position statistical units are used, they imply but do not necessarily designate the structure within which the position is to be found. Thus a group designated middle class may suggest a pretty good notion of the class structure within which this unit lies. Suppose, however, we converted measures of intelligence to standard scores and then designated percentile rank for individuals in standard scores. In the second instance we know the structure of percentile ranks to sum from zero to 100, but because we have used standard scores, we do not know from our percentile rankings what the actual scores were. The standard scores would facilitate comparisons between Navaajo and white American children, for example, by contrasting the proportions of each to be found in each percentile rank, but we would not know from this information what relationships the actual scores of the two groups bore to each other.

In general, statistical units are very convenient units to employ in research and theory building. Indeed, we habitually use this kind of unit largely because we have become sophisticated in putting much of the data of the empirical world into statistical form and it seems but natural that we retain this form in our analytical units.

It should be clear that statistical units have their special usefulness as well as their unique limitations. Within their own province such units yield excellent results when employed in theory building. But again, as with all the types of units we are describing, there is no logical reason for preferring statistical units over other types.

¹Examples abound, even in good textbooks. “Some communities are organized around a few occupations which engage chiefly one sex. For example, mining, cattle raising, or lumbering will attract a disproportionate number of males. Such areas have extremely high sex ratios.” George A. Lundberg, Clarence C. Schrag, and Otto N. Larsen, Sociology (New York: Harper & Row, 1954), p. 83. Or consider the following conclusions about the adaptation and integration of several groups (both being relational units): “In the long run, maladaptations will lead to malintegration.” Harry C. Bredeholt and Richard M. Stephenson, The Analysis of Social Systems (New York: Holt, Rinehart & Winston, 1962), p. 57.
**Summative Unit (S)**

The final class of units of a theory are designated *summative* units. I mean by a summative unit that it is a global unit that stands for an entire complex thing. Such global units are common in the behavioral sciences. It has become a fixture in recent American sociology to speak of the "mass society"; in economics we employ the designation "underdeveloped economy" to denote a wide set of properties that characterize such an economy; in psychology a summative unit is represented by the "other-directed" personality; and in anthropology such an analytical unit as "extended-kinship system" is a summative unit.

The central feature of a summative unit is that it seems to draw together a number of different properties of a thing and gives them a label that highlights one of the more important. A mass society is massive, but it also is heterogeneous, pluralistic, diffuse in goals, and so on. The unit *mass society* comes to stand for all of these properties and many more. We even feel that we can characterize an entire society as a mass society and then proceed to compare it with a class society or a caste society, using two additional summative units to form the comparison.

Analytically a summative unit is one having the property that derives from the interaction among a number of other properties. Without specifying what these other properties are, or without indicating how and under what circumstances they interact, we add them all up in a summative unit. Thus, a summative unit has the characteristic of meaning a great deal, much of which is ill-defined or unspecified. A considerable body of social-science literature is filled with such units. We feel no hesitancy in designating societies as gemeinschaft or gesellschaft types, as folk or urban, as sacred or secular. These units convey a great deal of meaning in communication, although they sometimes vary in content. In any event, a summative unit is always diffuse rather than precise, and implies much more than it states in its definition.

What, if anything, can be done with summative units when they are employed in theory building? It will be recalled that summative units are global and serve to characterize a bundle of properties at one time. Summative units are thus the most complex of all, as there is really no limit to the number of properties being characterized or to the ways in which these properties are related to each other. May we then employ such units in our theories with any profit or utility?

My answer is no. Such units are useless in theories and theoretical models that are designed for the purpose of testing propositions. Summa-

tive units have their function in a scientific discipline but not in relation to theoretical models.

Let us start with a quotation from Paul Lazarsfeld.

All the social sciences deal with concepts that seem somewhat vague. Who can, in practice, recognize an extrovert personality? Who has not read many discussions as to the real meaning of public opinion? Who can say precisely what a folk society is? There are various reasons why the social scientists' language has so many of these terms. . . . In some cases we can, by the nature of the concept, only observe symptoms, behind which we assume a more permanent reality. This would be true, for example, in the case of personality notions. In other matters the object of investigation is so vast that we can analyize only certain aspects of it: notions like patterns of culture of Zeitgeist belong here. For still other purposes the problem itself seems to require a looser kind of formulation: whenever we study adjustments—e.g., in marriage, in job performance, or in standard of living—we find that large numbers of actual solutions may serve the same functional purpose.

This peculiarity of the social scientists' intellectual tools has been deplored by some, considered as unavoidable by others. Most of all, however, it has been covered with nomenclature. Syndromes, genotypes, underlying concepts, hypothetical constructs, and many other terms have been used. It is hard to say to what extent we have today a clear formulation of the problem behind all these terms, let alone clear directions on how to deal with them in the pursuit of empirical research. And yet it is in the course of actual investigations that some clarification is most needed. For if we have to decide whether there is increased bureaucratization in government, or whether city life makes people progressively neurotic, we must get some measures of these tendencies. And whatever index we use, we make implicit assumptions about the meaning of the kinds of terms we have just exemplified.³

This quotation calls our attention to some of the shortcomings of summative units, at the same time alerting us to the fact that such units are commonplace in the social sciences.

The special usefulness of summative units is revealed by examining the structure of education in any behavioral-science discipline and probably in others as well. The beginning student is given a grasp of a field through contact with the summative units employed therein. From this he

gets a global view of what his discipline is all about and may even begin
to feel that he understands the content of the theories with which he deals.
In advanced instruction, attention typically shifts to more restricted types
of units and the global grasp of the subject matter of the discipline be-
comes splintered into bits of intensive knowledge that deal with only parts
of the familiar summative units. There is thus a pedagogical purpose
served by the use of summative units that is useful and efficient. At the
same time, developed sophistication in an intellectual discipline leads to
the substitution of the first four types of units of analysis for summative
ones.

Complex Units

It is possible that a unit employed in a theory may satisfy the definition
of two or more classes of units at the same time. For example, the
unit sex ratio (ratio of males to females in a group) clearly belongs to the
relational class of units. This same unit may be a member of the enumerative
class if we take sex ratio to stand for a characteristic of a group, or it
may be classified as an associative unit if it is a property of a group that
includes the possibility of being an all-female group (i.e., where the sex
ratio = 0). Finally, the sex ratio may be a statistical unit if comparisons
are made among groups according to the value of the sex ratio of each.

There is no essential problem in keeping clear the distinctive ways in
which the same unit may be classified into the four classes of units. What
is not always kept in view is the fact that the same named unit may have a
different meaning if it moves from one class to another. This, of course,
alerts the theorist to the need for distinguishing between the name used for
a unit and the context in which it is employed. Take again the unit sex
ratio. In a comparative study of birth rates, the sex ratio could be a
relational unit and, in this context, would denote the exposure opportuni-
ties that relate to intercourse probabilities and hence conception. In a
study determining the ecological structure of a city, on the other hand, the
sex ratio could be used as a statistical unit whose value for census tracts,
for example, would aid in locating distinctive types of neighborhoods.

The essential caution to keep in mind is that the same unit built into
one theory may have a different usage in another theory, even though an
identical name is used in each case. A significant aid in sorting out these
differences is the EARS classification of units of a theoretical model.
When a named unit falls into more than one class, this fact may be taken
as a signal to test whether it is then being used differently in the respective
models in which it is employed.

The Fit of Units with Each Other

Quite aside from the usefulness in research and theory building that
comes from classifying units of analysis, there is another consequence to
consider. Is it possible that we can mix and match different types of units
in our theoretical models, or must we be restricted in some way because
of the nature of the units themselves? This is a pertinent question, for if
any restrictions exist, this means that we have to find the rules governing
them in order to build permissible theories and avoid the logically inad-
missible.

There is no difficulty in perceiving that theories built up of identical
types of units present no analytical problems. We would feel logically
comfortable if a theory had only enumerative or only associative units
employed in it, for example. Similarly we would not blanch if we were
presented with a theory employing only relational units or statistical units
but not summative units. Essentially the notion of logical consistency
seems to be the criterion employed when we accept a theory composed of
a single type of unit.

The effect of employing only enumerative units results in the use of
just the first quadrant of a Cartesian coordinate system, in a two-unit
theory. In this quadrant all possible values of the two units can be plotted,
and because they are enumerative units, neither has a zero value or
negative values. Figure 4-1 illustrates where our analytical attention is
focused. In principle, this can be extended to \( n \)-dimensional coordinate systems with the analogous quadrant being populated, although only the two-dimensional situation has been illustrated in Figure 4-1.

In a similar fashion the effect of building a theory of only associative units may be visualized. With a two-unit theory all four quadrants of a Cartesian coordinate system would be utilized, as shown in Figure 4-2.

Similarly, combining enumerative with associative units in a single theory results in the spread of data through two of the four quadrants of a Cartesian system. This is portrayed in Figure 4-3.

In general, we may conclude that both enumerative and associative units may be employed without restriction in the same theory either together or exclusively.

Relational units, as we have seen, are in themselves complex, being the property derived from the interaction or combination of two or more other properties. How then may relational units be used in conjunction with other types of units? It seems clear that relational units may be employed exclusively in a theory with no difficulty. Indeed, a good deal of social-science theory is built out of relational units. For example, it is possible to build a theory about subordination and sibling rivalry, both units being themselves relational units. We could theorize that those who experience minimum sibling rivalry as children in other than single-child families will exhibit the most acceptant behaviors in situations demanding subordination as adults. The assumption is that learning and accepting a place in a birth-ordered social system is positively socializing with respect to behaving like a subordinate as an adult.

Relational units can also be combined with either enumerative or associative units in the same theory. Logic would suggest that if relational units are the product of two or more properties of things, and these properties are themselves either the elementary enumerative or associative properties, then there should be no difficulty in using relational units with either enumerative or associative units. This in fact is the case.

It is of particular interest to note the special research design used when relational units (made up of the combination or interaction of enumerative and associative units) are combined with other enumerative or associative units. This results in a trait-analysis format. That is, the relational unit is assigned the status of dependent unit in the design, and we then proceed to use enumerative or associative units as the units whose values predict the values of the relational unit. Thus, we may use the relational unit leadership as the dependent unit and attempt in the theory and its related research to account for the variance in the amount of leadership that may be associated with such units as birth order, education, and age. The purpose of such research is to find those traits that seem to account for the unit values of the relational unit, leadership.

One of the obvious logical impasses that is almost never recognized in research is the attempt to break down the dependent relational unit through a theory that relates it to the component properties of which it is constituted. For example, suppose we took intelligence as the dependent relational unit (it does, in any system, turn out to be a relational unit determined by the combination or interaction of primary mental abilities) and correlated it with number ability or verbal ability. When we do this, we are, in effect, guaranteeing a correlation because the enumerative units are, in their interaction with others, the components of the relational unit whose values we consider dependent upon the identical enumerative
units. Put another way, it we relate a thing to itself, we are bound to find a correlation.9

Self-correlation should not be confused with the goal of parsing a complex relational unit into its parts. There is a very important theory-building research activity that is directed at finding the constituent units of a relational one. Some very seminal research and the developments of a first-rate research technology have centered on this problem. For example, when Thurstone sought out the "primary mental abilities" he was trying to find the minimum number of enumerable units that taken together would describe intelligence, an obvious and important relational unit. Thus, the research goal was to find the elementary properties, and their mode of combination, that constitute the relational unit *intelligence*. In attacking this problem Thurstone developed multiple-factor analysis as an exceptionally useful and important research technology addressed to this parsing problem. Particular attention to this issue occurs in a succeeding section of this chapter dealing with discovering new units of analysis.

9Following is an example of self-correlation involved in employing a relational unit based upon combination. You will note that the author reported the correlation between his composite measure and the four individual measures making up this composite. It is not surprising that these self-correlations are among the highest in the table.

Matrix of Intercorrelations of Variables Relating to Eminence for 566 Highly Visible APA Members Who Received Their Doctoral Degrees in the Period 1930-44

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) APA Offices Held</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Total Psych. Abstracts Counts</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) 1950-53 Psych. Abstracts Counts</td>
<td>.20</td>
<td>.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Annual Review Citations</td>
<td>.31</td>
<td>.42</td>
<td>.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Journal Citation Counts</td>
<td>.39</td>
<td>.47</td>
<td>.36</td>
<td>.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Composite of 1, 3, 4, 5</td>
<td>.80</td>
<td>.53</td>
<td>.52</td>
<td>.71</td>
<td>.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) No. of votes received</td>
<td>.64</td>
<td>.47</td>
<td>.43</td>
<td>.58</td>
<td>.68</td>
<td>.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Current Ph.D. Students</td>
<td>.11</td>
<td>.19</td>
<td>.23</td>
<td>.18</td>
<td>.18</td>
<td>.20</td>
<td>.23</td>
<td></td>
</tr>
<tr>
<td>(9) Total Ph.D. Students</td>
<td>.23</td>
<td>.25</td>
<td>.17</td>
<td>.29</td>
<td>.32</td>
<td>.35</td>
<td>.34</td>
<td>.63</td>
</tr>
</tbody>
</table>


**Units of a Theory**

The first prohibition against the use of certain combinations of units in theory building is

*A relational unit is not combined in the same theory with enumerative or associative units that are themselves properties of that relational unit.*

To derive the second prohibition against certain combinations of units, let us continue the analysis with an examination of statistical units. The very nature of statistical units is that they describe properties of collectives. That is, the property of central tendency or of dispersion or of relative position can only be described for a collective unit. This now raises a problem. Can we employ units describing a member in the same theory with units describing a collective? We divide the problem into two parts.

Where a unit describing a property of a collective and a unit describing a property of a member deal with a member that is part of that collective, then we cannot employ these units in the same theory. Suppose, for example, we know from a study of school children that the relationship between intelligence and test scores in arithmetic may be expressed in the statement "On the average, test scores rise two points with every increase of five points in measured intelligence." We now use this knowledge based on the collective "school children" to predict that two children drawn from the same sample population will have arithmetic scores differing by 10 points if one measures 100 on IQ and the other measures 125. We are trying to predict, from a knowledge of two statistical properties of a collective, the values that will be associated with a member of that collective. Robinson has shown that this cannot be done.4 The logic seems clear. Even though the value of the property on the member has gone into the determination of the property of the collective, we cannot locate from a knowledge of the collective property the value of the member property. It will be noted in Table 4-3 that the collective property "average numerical value" for the group composed of *A, B, C, D, and E* is 16. This empirical property of the collective does not permit us to draw any inference about the value of the member property for any individual member. There is an infinite number of sets composed of five members, constituting collectives that can have the collective property of an average numerical value of 16.

This gives rise to the second rule regarding the combination of different kinds of units in the same theory.

*Where a statistical unit is employed, it is by definition a property of a collective. In the same theory do not combine such a statistical unit*
Table 4-3

<table>
<thead>
<tr>
<th>MEMBER</th>
<th>NUMERICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>17</td>
</tr>
<tr>
<td>D</td>
<td>19</td>
</tr>
<tr>
<td>E</td>
<td>24</td>
</tr>
</tbody>
</table>

with any kind of unit (enumerative, associative, or relational) describing a property of members of the same collective.

There is one general exception of the rule just stated. This exception deals with the empirical location of a sample with respect to a universe and is not, properly speaking, a problem for theory building. Suppose we ask the question, "Does a given sample set of values of a property for a group of members indicate that these are members of a given collective?" Here the problem is to determine in which collective a sample of members belongs. For such a problem the property value of the members individually may be compared with the value in the collective to reach a decision. Suppose, for example, that the range of values for a collective is between 10 and 63 and members of a sample have property values ranging between 64 and 72. It would seem reasonable to conclude that this group of members does not belong to the specified collective. The theory of the statistical tests of significance rests on the solutions of this problem of the location of members with respect to the properties of collectives. The answer as to whether the sample belongs in the collective or not only answers that question and has no further theoretical significance. Why it does or does not belong in the collective is not revealed from a knowledge of the property characteristics that have established this membership or nonmembership.

A more complex problem has to do with whether or not we can employ statistical and other types of units in the same theory when the other types of units are properties of things not members of the statistical unit being employed.

When statistical and enumerative (or associative) units are joined together in the same model, the typical (but not logically necessary) format is to use a statistical unit expressing relative position. For example, in survey research the respondents in a sample may be divided into three subgroups, high, low, and average, in a statistical unit measuring one collective characteristic. These relative positions are then cross-tabulated with a characteristic measured by an enumerative or associative unit. Consider a table in which productivity is the statistical unit:

Relation of Group Belongingness to Productivity (Workers in a Tractor Factory)

Employee question: "Do you feel you are really a part of your work group?" (Significant between .05 and .10 level.)

<table>
<thead>
<tr>
<th>EMPLOYEES WITH PRODUCTIVITY OF:</th>
<th>INCLUDED IN MOST A PART (1) WAYS (2)</th>
<th>INCLUDED IN SOME WAYS (3)</th>
<th>NOT ASCERTAINED</th>
<th>TOTAL</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-119%</td>
<td>58%</td>
<td>24%</td>
<td>10%</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>90-99</td>
<td>56%</td>
<td>29%</td>
<td>10%</td>
<td>5%</td>
<td>100%</td>
</tr>
<tr>
<td>80-89</td>
<td>51%</td>
<td>31%</td>
<td>13%</td>
<td>5%</td>
<td>100%</td>
</tr>
<tr>
<td>70-79</td>
<td>52%</td>
<td>28%</td>
<td>10%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>40-69</td>
<td>46%</td>
<td>31%</td>
<td>15%</td>
<td>8%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The authors conclude from this table that "high-producing employees... reported that they felt that they were 'really a part of their group,' in contrast to the lower producers who were more likely to say that they were 'included in some ways but not in others,' or that they did not really feel that they were members of the group."

This descriptive conclusion is wholly inadequate, as a glance at the table will reveal. Apparently the conclusion derives from an exclusive focus of the 58 percent of the first cell of column 1 and the 15 percent in the last cell of column 3. All the off-diagonal values are ignored, as are the relations among column percentages. For example, among the lowest-productivity workers there are 46 percent who feel they are "really a part" of their own work group, which hardly fits the conclusion of the authors. (Furthermore, the authors reached the conclusion that the lowest producers "... did not really feel they were members of the group," a result for which there are no data presented at all!)

Caution must be observed in employing statistical units in the same model with enumerative and associative units. The caution is this: Do not

draw conclusions from only one portion of the empirical relationships found.

When statistical units are employed in a model together with relational units, the caution just stated becomes even more imperative. Such a model employs the most complex units possible. Consider the following illustration.

Katz and Lazarsfeld devoted a full volume to the analysis of personal influence. At one point they were concerned with the leadership of women in public affairs. Their data first led to the conclusion that women of the high status level are three times more likely to be public affairs leaders than women of low status. . . .

We asked the women in our sample about several items which were then current in domestic and foreign affairs and from their responses constructed an index of public affairs information. . . . Table 33 indicates the relationship between status level and public affairs information and interest:

**Table 33. Information Level Increases with Each Step Up the Step Ladder**

<table>
<thead>
<tr>
<th>SOCIAL STATUS LEVEL</th>
<th>PER CENT WITH HIGH INFORMATION (%)</th>
<th>TOTAL (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>72%</td>
<td>(197)</td>
</tr>
<tr>
<td>Middle</td>
<td>52%</td>
<td>(253)</td>
</tr>
<tr>
<td>Low</td>
<td>28%</td>
<td>(246)</td>
</tr>
</tbody>
</table>

. . . Because the distribution of information among the three status levels parallels the distribution of opinion leadership, we were led to ask . . . whether it might not simply be that the more informed people are the opinion leaders and . . . that status is related to public affairs leadership only insofar as it brings with it differing concentrations of informed people. If this is so, we should find that equally interested people, regardless of their status level, should have roughly the same chances for opinion leadership. Table 34 shows . . . this is not the case:

**Table 34. Public Affairs Leadership Still Varies According to Social Status Even When Information Level Is Controlled**

<table>
<thead>
<tr>
<th>INFORMATION LEVEL</th>
<th>HIGH STATUS</th>
<th>MIDDLE STATUS</th>
<th>LOW STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>21% (141)</td>
<td>15% (127)</td>
<td>10% (69)</td>
</tr>
<tr>
<td>Medium</td>
<td>16% (45)</td>
<td>11% (79)</td>
<td>8% (77)</td>
</tr>
<tr>
<td>Low</td>
<td>—</td>
<td>2% (40)</td>
<td>1% (97)</td>
</tr>
</tbody>
</table>

It will be noted that the second relationship, as revealed in Table 33, is between a statistical unit, percent with high information (based upon a metric, index of public affairs information) and a relational unit, social status level. In order to establish how these units are related to leadership, the authors were constrained to subdivide the individuals in each social status level into three groups distinguished by their level of information. Then, within each cell, the proportion of women of that status level and level of information who were public affairs leaders was set forth. Thus, in Table 34, 21 percent of the 141 high-status—high-information-level women were leaders. From this subdivision of the sample by the addition of the associative unit leadership in public affairs, it is then possible to work out the relations between status (a relational unit) and informational level (a statistical unit) as they together are related to leadership.

The analytical steps, as far as units are concerned in this example, include (1) finding a relationship between a statistical and a relational unit, (2) introducing a new unit into the model, and thereby changing the starting model, in order to simplify the relations between the statistical and relational units, and (3) then concluding how the three units are interrelated.

The Katz-Lazarsfeld example may be generalized. A model employing statistical and relational units is one foredoomed to be subdivided into several theories. Such models, however, are quite useful in exploratory research, where the field being probed is little known and the models of it are imprecise. The guidance given to research by models composed of statistical and relational units permits a gross empirical attack on a domain from which future refinements may evolve.

Turning to summative units, it may first of all be asserted that such units are employed widely in two related contexts. (1) When the beginning student is being inducted into an intellectual domain, his introductory contacts are largely focused on summative units of analysis. (2) When the expert in a field of inquiry is addressing a lay audience, he will . . .

employ summative units. Both cases display a common feature: a field is being presented to a nonsophisticated audience.

Summative units, therefore, serve a very important purpose in sensitizing an audience to the boundaries of an intellectual domain and giving it some grasp of the main dimensions of that field. In short, summative units are functional in education. This is not to be ignored as an important and useful function. Nor should an instructor in a beginning course of a discipline eschew summative units because they lack utility in theory building. An important skill of an educator is being able to sensititze a beginning student to a field by employing summative units, and then weaning the student from global units of analysis to the kinds of units employed in building scientific models. This is indeed the history of all courses beyond the introduction to a social-science discipline.

Summative units have utility in education of and communication with those who are naive in a field. Summative units are not employed in scientific models.

This section started with the mnemonic device, EARSS, to identity units employed in theory building. The final conclusion is that the last S, standing for summative units, is inadmissible. Thus, we simplify to EARS to denote the following: E = enumerative units; A = associative units; R = relational units; S = statistical units. Theories in the behavioral sciences employ these four types of analytical units. Their employment in conjunction with each other is subject to the limitations suggested in this section.

Selecting Units

In principle there are no limitations on the selection of units to be employed in a theoretical model. The theorist has unlimited opportunities to employ units of his choice. Once he has made his selection, the constructed models must conform to the limitations set forth in the previous section for employment and combination of units.

It has not always been accepted that the theory builder has unrestricted choices among units. In the recent past, important social scientists have urged that only units capable of being operationalized were admissible in theory building. In a contemporary period, Talcott Parsons has urged that the formulation of theories as mathematical models may be premature because, we may infer from his argument, the units required may be unduly restrictive. Mathematical models do not require units that must be in some metric form, although some scholars may confuse precision of units with their analytical power. Our discussion should have made clear that attribute units can, in fact, be more powerful than variable units that are denoted by a metric.

At the other extreme have been social analysts who have employed summative units in what has long passed for theory in various social-science disciplines. Summative units do not have a place in theories. However, the phrase frame of reference describes an intellectual construct in which summative units play a central role. All frames of reference employ summative units, and some are made up exclusively of summative units. A frame of reference is an educational device used in orienting a layman (student or non-expert) to a field of inquiry, as already noted in the discussion of summative units. When summative units are employed in analytical thinking, they succeed admirably in functioning to delineate a frame of reference. A frame of reference is constructed by educators for pedagogical purposes, legitimate in their own right. Theories and models are not frames of reference.

Discovering New Units

The discovery of new units to be employed in theory building is basically achieved through a process of classification. Such classification has two general forms. We either take a broad unit and subdivide it, or we elaborate a residual unit into a substantive one and thus extend the existing classification scheme.

Invention by Extension

The invention of new units by extension of an existing classification scheme is probably the more familiar procedure. What is involved here is
the addition of new categories to an existing classification, or the specification of a previously recognized residual category. This can best be illustrated in the description of the origins of a classification of industrial work groups by Sayles.

As the data were accumulated and reviewed it appeared that what was being described to us was not one but a variety of work groups. These groups differed from one another very substantially, particularly in the way in which they dealt with any problems they faced. For the sake of convenience we have attached names to the four types most clearly distinguishable: the Apathetic, the Erratic, the Strategic, and the Conservative.10

Extension of classification is vigorously employed in the discovery of new units in the behavioral sciences. Rostow, for example, did this when he invented the classification scheme delineating the levels of economic development; and Freud did this when he distinguished the ego from the id and both from the super-ego. In sociology Burgess extended the units for analysis of the ecology of the city with his concentric zones, and this in turn was modified by Hoyt, who further superimposed a sector structure upon the zone classification. Merton developed his fourfold classification of individual deviant adaptations to social systems, and Dubin later extended this to include group deviations and found that the scheme required fourteen classes of deviant adaptations instead of four. The examples come readily to hand, and you can easily draw upon your own experience to multiply the illustrations.

The salient feature of the extension of an existing classification scheme is that it is one process for discovering new units. Each time a classification scheme is extended by adding new categories or specification of a residual category, one or more units are added to the repertory. We ordinarily do not think of invention in these terms, and it is therefore worth underscoring this point.

**Invention by Subdivision**

When a class is subdivided, the operation is typically for the purpose of securing finer discriminations within the range of existing units. Most often (if not always) this is accomplished by using other existing units as the basis for subdivision. For example, within the units male and female we may wish further to distinguish marital status and age. The resultant typology might be represented by units males-married-young, males-single-young, males-married-old, and males-single-old.

It is notable that in this subdividing process well-known units are typically employed. The inventiveness involved in producing a new unit is entirely tied up with the particular combination of familiar units. The subdivision process, then, involves emphasis on the inventiveness of the theorist in the manner in which he combines familiar units into unique combinations to produce a new unit.

There is no principle that demands only that familiar units be employed in the subdivision process, as in our previous example. In principle, we may use either customary or new units to achieve subdivision. The fact that one may produce new units out of the familiar is, of course, an extremely comforting circumstance for the theorist-researcher. It means that to be original demands only a focus on the recombination of the familiar rather than the sometimes more strenuous demand to be original by creating an entirely new unit from thin air.

There are available specific research technologies that are addressed to the problem of the discovery of new units of analysis through the twin processes of extension and subdivision. The use of the so-called “null hypothesis” is addressed to the problem of invention by extension. The technology of factor analysis produces an objective solution to the issue of invention by subdivision.

**Invention and the Null Hypothesis**

When the null hypothesis is employed the purpose is to inquire as to whether the designated not-X unit is really X. When we use the null hypothesis, our assumption is that there is no significant difference between measured values of the sample representing the X unit and those representing what is designated not-X. If no statistically significant difference is found, it is safe to assert that both samples may be counted as being examples of the X unit. If, however, there is a statistically significant difference, then we are impressed with the need for inventing a unit specification for what we had previously been satisfied to call the not-X unit. In short, the empirical reality of a population bearing a not-X unit designation leads us immediately to translate this residual definition into an affirmative one. Under these circumstances the null hypothesis plays
an exceedingly important role in the process of discovery of new units of analysis.

**Invention and Factor Analysis**

Factor analysis is an especially powerful tool for inventing new units by subdivision. In much simplified form the procedure of factor analysis is to subdivide a unit into other units. Thus, intelligence as a property may be subdivided into primary mental abilities; culture may be accurately described as the composite of specific national characteristics; and personality may be mapped into its component parts.

The essential feature of this process of discovery of new units through factor analysis is to subdivide a large unit and then establish the relationship of the new units to each other. The complement of new units taken together constitutes the factoring of a starting unit through factor analysis. The particular beauty of this technique is that it provides an objective way for determining how far one goes in the factoring process and when to stop. The technique has been employed primarily in psychology, where it was developed, and is only lately coming into use in sociology and anthropology. It could find much wider application in these disciplines but perhaps not because of the more common tendency to invent new units by extension.

It might even be suggested that the stage of development of a discipline is revealed by the emphasis on the ways in which new units are advanced in the field. If extension is the method primarily employed, then the discipline is probably relatively new, and analytical attention is still directed at filling out the collection of analytical units employed. If the discipline is well established, then analytical attention may turn to filling

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**Invention and Scale Analysis**

There is a special case in social science, inspired by factor analysis, in which the problem of discovery of new units is the focus of a research technology. Scale analysis is used in the general circumstance where the investigator is concerned with finding out whether certain things hang together. The technique was developed especially to deal with the responses of individuals to questions in order to find out whether the response to one question was directly linked to the response to another. When these linkages occurred with a high degree of invariability, then the questions were said to scale and the response patterns to differentiate respondents into distinctive types of units of analysis.

From our standpoint, what is most interesting is that items that do not scale according to the technical criteria of scale analysis are discarded. The criterion of discard is that the items do not scale with those retained. There is no contention that the discarded questions do not measure something. Hence, scale analysis is an effective way of inventing new types in the scale developed or in the distinctive scale types that emerge from a study. We also have, and this is scarcely given recognition, an effective negative way of inventing new units from among the items discarded as being nonscalable in a given instance. Indeed, this discard heap of nonscalable items should be guarded jealously as an important source for the discovery of new units of analysis. Unfortunately, our habits of research report writing do not encourage this stockpiling of intellectual discard.

**Invention and Intervening Variable**

To employ the concept of intervening variable usually involves an implicit admission that the starting theoretical model is inadequate and
must be supplemented by addition of the intervening variable. When the relationship between two units of a model is the focus of attention, it is presumed that the values of the units co-vary. We have already indicated that the choice of particular units employed in a model is arbitrary. The model builder is wholly free to choose those units that to him make sense as the components of a theoretical model. Having made such initial choice, however, he is subsequently constrained, as we shall see in the next chapter, to determine laws by which these units interact in order to produce the outcome values for the units predictable from the model. Given this task as the task of model building, the researcher must make certain that every unit employed in the model interacts in a lawful way with at least one other unit of the model.

The arbitrary focus on particular units to be employed is often dictated by the current intellectual fashions and fads of a discipline. In order to retain disciplinary respectability, and at the same time deviate respectfully from the current fads and fashions, a researcher often employs traditional or highly reputable units. He moves toward innovation and deviancy by considering alternate units as intervening variables in the models he constructs. Thus, there tends to be introduced into theoretical model building a process of gradual revision by which intervening variables become the vehicles for modifying traditional units of analysis. Subsequently, the researchers may take the new intervening variables as the new established traditional units, discarding the older traditional units as being more remote from the outcome values of the units they are attempting to predict. The intervening variable in this context plays a role in the intellectual preferences for particular units of analysis. Intervening variables provide a mechanism for changing traditional units of analysis. The notion of intervening variable turns out, then, to be a convenient fiction by which the traditional units employed in a discipline come to be modified.

In the logic of intervening variable, there are three senses in which the concept has been employed. (1) The intervening variable, or, as I shall now designate it, the intervening unit, is seen as being literally closer to the outcome being predicted by the model than the unit being intervened upon. The theorist asserts that he can predict the outcome values of a unit from the values of the intervening unit because the connection with the unit whose values are being predicted is more immediate and direct than is the linkage between the outcome and the original unit employed. In this first logical sense, research tactics are directly initiated at the analysis of models in which the units chosen are lawfully related to each other in the most direct possible fashion. If parsimony in model building is a desirable goal, then the model should employ a minimum number of units. The selection criterion for satisfying parsimony can be the immediacy of the relationships among the units in predicting the outcome values for any single one.

A second logical view of intervening units is this: (2) The values of a given unit are related to the values of another unit by two routes. The first route is a direct relationship between the two units. The other route is through a third unit. Thus, the two original units included in the theory turn out to be related in a dual fashion, requiring the addition of a third unit to the model in order to describe the total relationship. In this sense of the intervening unit, the criterion of parsimony in model building (as examined in the case in the preceding paragraph) would no longer be appropriate. Consequently, it would be inaccurate to discard either unit being intervened upon in favor of the intervening unit as dictated in the first case. On the other hand, to include such an intervening unit in this second case also requires that the laws of interaction among the units of the model be modified. This is made necessary to take into account both direct interaction among the units and also indirect interaction through linking chains in which some units stand in an intermediate position between others. Thus, the consequence of using intervening units in this second case is to develop more complicated theoretical models by adding one or more units and laws of interaction to the model.

There is a third case in which the idea of intervening unit plays a part. (3) A unit chosen for a model may be designated as an ultimate antecedent because it is temporally prior and lawfully connected to the outcome being predicted. An intervening unit may be viewed as being temporally closer to the outcome unit. In this case the researcher uses a chain type of model because he is interested in temporally linked chains in which the discovery of all possible links in the chain is of central concern. Thus, in a sequence, if A precedes B and B in turn precedes C, it may be argued that A is a more important antecedent of C than B because A occurs first in time in the linked chain of A to B to C. In such a situation, B would be called an intervening unit. It should be noted that this case can be distin-

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guished from Case 2. In this third case the ultimate unit farthest removed from the dependent unit is linked to the latter only through one or more intervening units, and never directly. There is an obvious consequence of this linkage system among units of the model. If the values of unit A are predictive of the values of unit B and these in turn are predictive of the values of unit C, then we need two separate and distinct laws of interaction to link A with B and B with C. In this third case, it is impossible to establish a law of interaction between unit A and unit C. From this standpoint, the intermediate unit B can no longer properly be thought of as an intervening unit. It has just as much independence as any other unit.

**Invention and Discarded Units**

In general it should be pointed out that it is not uncommon to strain for consistency in or among units of analysis, with the result that important data may be cast out that could be the source of invention of new units. Put another way, the theory builder is often well advised to inquire about the data that researchers collect but subsequently exclude from their research analysis. These data may be mined for important insights about new units.

When it is possible to postulate no interaction between two units, we may exclude one or both from a model. In one sense the statement of no relationship between two units is a lawful one, but it is in the form of a null statement. The purpose of considering this possibility in building any theoretical model is that it leads directly to limiting the units among which choices will be made. Thus, to say that there is no relationship between two units is to say that there is no theoretical model for which these two units taken together can constitute components.

There is a caution to be observed here, however. Because previous studies have found no relationship is not necessarily a good reason for continuing to believe no relationship exists. One point at which scientific ingenuity is exercised is to reexamine such rejected pairs or n-tuples of units for the possibility that a lawful relationship between them and other units can be postulated. If, for example, you are not interested in bananas in the first place, then you will not look to see if the volume of bananas imported is lawfully related to the U.S. birth rate. Statistics texts have used their empirical relationship to demonstrate spurious correlation. I would argue that the empirical correlation may be subject to lawful formulation, and this possibility should never be ignored, even though it may have a face improbability.

**Descriptive Research**

There is no more devastating condemnation that the self-designated theorist makes of the researcher than to label his work *purely descriptive*. There is an implication that associates "purely descriptive" research with empty-headedness; the label also implies that as a bare minimum every healthy researcher has at least an hypothesis to test, and preferably a whole model. This is nonsense.

In every discipline, but particularly in its early stages of development, purely descriptive research is indispensable. Descriptive research is the stuff out of which the mind of man, the theorist, develops the units that compose his theories. The very essence of description is to name the properties of things: you may do more, but you cannot do less and still have description. The more adequate the description, the greater is the likelihood that the units derived from the description will be useful in subsequent theory building.