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Functions of theory.

Theory and "theorizing" in international relations serves a purpose similar to that in other branches of the social sciences of superimposing a sense of order upon data that otherwise would be disorderly. The building of theory in international relations makes it possible to explain how international systems and processes *may* operate and provides the basis for developing laws which will explain and predict future behavior by the actors in the international system. By the use of theory, patterns can be ascertained and generalizations articulated in a manner that is meaningful and fruitful in terms of the varieties of approaches to the study of the phenomena of international relations. The principal function of theory is "to make sense of what would otherwise be inscrutable or unmeaning empirical findings." (Kaplan, 1964, p. 302.)

Theory cannot introduce order where none exists; however, order is not discernible in social phenomena except through the operation of implicit or explicit theorizing. Theory systematizes and establishes relationships among variables providing the basis for the scientific processes of explanation and prediction. Only by means of theory can we explain how the international system operates and how we may expect actors to behave within the system. Rudner's definition is quite appropriate: "*A theory is a system-*

atically related set of statements, including some lawlike generalizations, that is empirically testable." (Rudner, 1966, p 10, Rudner's italics.)

> What is meant by saying that the statements, of a certain set of statements, are systematically related in the sense relevant to our present concerns? Almost anyone who reaches the age of reason in Western society has at least an inkling of the import of the term. We are all familiar with the view that it is not the business of science merely to collect unrelated, haphazard disconnected bits of information; that it is an ideal of science to give an organized account of the universe --to connect, to fit together in relations of subsumption the statements embodying the knowledge that has been acquired. Such organization is a necessary condition for the accomplishment of two of science's chief functions, explanation and prediction. But the sort of systematic relatedness exemplified among the statements of scientific theories is deductive relatedness. Accordingly, to the extent that a theory has been fully articulated in some formulation, it will achieve an explicit deductive development and interrelationship of the statements it encompasses!
> (Rudner, 1966, p 11, Rudner's italics.)

Deduction, induction and retroduction.

There is much support in the literature for the conclusion that scientific theory is deductive; for example, Spence's statement that "Theories of physics are constructions which serve primarily to integrate or organize into a single deductive system sets of empirical laws which previously were unrelated . . . ." (Quoted in Kaplan, 1964, p 302.2.) A similar formulation is presented by Hall: ". . . . a theory is a systematic deductive derivation of the secondary principles of observable phenomena from a relatively small number of primary principles or postulates, much as the secondary principles of theorems or geometry are ultimately derived as a logical hierarchy from a few original definitions and primary principles called axioms." (Hull, 1943, p 2-3.)

Hansen argues that the formulation of the principal physical laws (such as those of motion, thermodynamics, electromagnetism, etc.) have been explained in two different ways: first, it has been asserted that the laws were developed inductively by means of observing the phenomena and arriving at the articulated theories which explained and predicted such phenomenal behavior. "A second account treats these laws as high-level hypotheses in a hypothetico-deductive system." (Hansen, 1958, p 70.) The latter, Hansen argues, describes physical theory more completely and more satisfactorily than did explanation by the induction-by-enumeration method. Hansen argues that physicists do not start from hypotheses, they start from data.

By the time a law has been fixed into a [hypothetico-deductive] system, really original physical thinking is over. The pedestrian process of deducing observation statements from hypotheses comes only after the physicist sees that the hypothesis will at least explain the initial data requiring explanation. (Hansen, 1958, pp. 70-1.)

Peirce argues that neither induction nor deduction are devices for building theory so much as they are devices for testing theory. Induction according to this view "sets out with a theory and it measures the degree of concordance of that theory with fact. It never can originate any idea whatever. No more can deduction. All the ideas of science come to it by the way of Abduction [Retroduction]. Abduction consists in studying facts and devising a theory to explain them. Its only justification is that if we are ever to understand things at all, it must be in that way. Abductive and inductive reasoning are utterly irreducible, either to the other or to Deduction, or Deduction to either of them . . . . Deduction proves that something must be; induction shows that something actually is operative; Abduction merely suggests that something may be." (Quoted by Hansen, 1958, p 85.)

As Hansen demonstrates, the logical processes of deduction, induction and retroduction are not mutually exclusive. Given a body of data, we might prove conclusively by deduction that $x = 2(ab)^2$; we may demonstrate inductively that $2(ab)^2$ is a function of x; we may hypothesize retroductively that any $2(ab)^2$ is a function of x. Deduction and induction are limited by the data -- one cannot logically deduce or induce in the absence of the data. We cannot identify voting patterns in American elections short of collecting statistics and drawing statistical inferences (induction). Once established, we can determine the extent of deviation from voting patterns by means of deduction. Having identified patterns and tested some hypotheses, we may formulate some generalizations retroductively about voting patterns in democratic polities.

Formalization.

Obviously, deductive, inductive, and retroductive (abductive) reasoning pertain in the social and behavioral sciences as well as in the physical and biological sciences. That which distinguishes the latter from the former is not the nature of inquiry so much as it is the degree of formalization found in the various disciplines. "Full formalization" exists when theories "are formulated as completely articulated deductive systems." (Rudner, 1966, p 11.) The physical sciences tend to be highly formalized, the biological sciences less so and the social and behavioral sciences tend to be only partially formalized.

> A theory, in a substantially formalized system, includes as constituents (1) an uninterpreted or formal calculus which provides for syntactical invariance in the system, (2) a set of semantic rules of interpreta-

> tion which assign some determinate empirical meanings to the formal calculus thereby relating it to an evidential or empirical base, and (3) a model for the uninterpreted calculus, in terms of more or less familiar conceptual or visualizable materials, which illustrates the relationships between variables in structural form, an alternative interpretation of the same calculus of which the theory itself is an interpretation. (Gregor, 1968, p 425.)

Because they are partially formalized systems, the social sciences do not lend themselves to developing the degree of linguistic and logical precision that is to be found in a more highly formalized system such as physics. However, as Kaplan argues, the distinction may not be so much one between the disciplines as between the varieties and types of theories that are developed in the social and physical sciences. Validation of theories is more readily achieved in the physical sciences than in the social sciences because ambiguity is more readily accepted in the latter than in for former. Gregor argues very effectively, as does Rudner, that scientific inquiry and theory building can proceed in the social sciences despite the apparent difficulties and limitations so long as the scholar is careful and precise in the articulation of hypotheses and in the assertion of theoretical interrelationships.

> Partially formalized systems lack, in varying measure, the logical and linguistic precision afforded by full or extensive formalization and are consequently suspect. This cannot be construed to mean that scientific inquiry in areas where formalization has not been achieved must cease until such time as extensive or exhaustive formal systematization is forthcoming. Significant empirical generalizations and a wealth of descriptive material have been the product of diligent enterprise in the partially or minimally formalized sciences. All that can be legitimately implied by the recognition that a discipline is only partially or minimally formalized is that self-conscious efforts should be made to identify sources of error--vagueness, ambiguities, reifications and tense obscurities--and the equivocations and vacuities that are their too frequent consequences. (Gregor, p 426.)

Largely as a result of such partial formalization, historically there has been relatively little incrementalism in the social and behavioral sciences as compared to the biological and physical sciences. In the former it takes special care to identify and evaluate those properties of one theory which are transferable to another. This is not the case in highly formalized disciplines.

Discovering that the earth was round sufficed to demonstrate that previous theories relating to the earth as being flat were no longer valid. The distinction may be summarily described with reference to Nils Bohr's distinction between trivial and profound truths. Trivial truths were, to Bohr, those for which the negation was obvious--establishing the truth proves contradictory concepts to be false. Profound truths were those for which the negations were also profoundly true because they could not be disproved experimentally or empirically. The more highly formalized the discipline, the more it will be concerned with trivial truths; i. e., the development of theories and their empirical validation serve to demonstrate the falsity of previously held incompatible theories. In the social sciences frequently the development and empirical testing of theories serves to shed greater light than was previously present but does not in most cases disprove previous theories.

Incrementalism and universalism.

The social sciences, then, have tended to become cluttered with great bodies of theories of varying degrees of explicitness or comprehensiveness. The cluttered nature of international relations theories is only in part a function of the profundity of the discipline's concerns. Of perhaps greater importance are the lack of incrementalism and universalism present in most theories in the field. Incrementalism in the physical sciences results in replication of experiments by succeeding generations of students and, as a function of replication, in the constant reexamination of all aspects of the experimental design: from the framing of hypotheses through the methodology of the research to the findings. Given the essential formalization of those disciplines, such replication and reexamination can be pursued ad infinitum. The constraints that are imposed upon scholars of the field by having their work subjected to constant testing and retesting means that previous theories must be reinforced to be retained. If they are not borne out in the replications something must be wrong with the theories. Thus, Kepler, by careful reexamination of Tycho Brahe's mapping of the circular orbit of Mars, found that Brahe's theory was in error. As a result, Kepler discovered the elliptical orbit of Mars and, by extension, of the other planets in the solar system.

> This was a physical discovery. Since the same physical conditions obtained throughout the solar system, the same equations ought to explain other planetary revolutions as well. These three great explicantia are the well-known result: (a) that planetary orbits are elliptical with the sun in their common focus (1609), (b) that they describe around the sun areas proportional to their times of passage (1609), (c) that the squares of the times of their revolutions are proportional to the cubes of their greater axes, or their mean distances from

> the sun (1610). These are most important in the history of astronomy. They supplied the material for Newton's retroduction [abduction] to the law of universal gravitation. (Hansen, p 84.)

The other major distinguishing feature of the theories in international relations from those in the biological and physical sciences is the universalism of most international relations theories. This is not to state that universalism is not present in biological and physical theories--the illustration just cited is evidence of universalism at its best. But where universalism in the biological and physical sciences is retroductively arrived at, universalism in the social sciences tend to be arrived at through intuition and insight. To be sure Galileo, Newton or Kepler made effective use of intuition and insight but did not confuse those techniques with observation and experimentation. Universalism in the social sciences often follows from intuition fed by loosely drawn analogies which all too often substitute for observation.

Universalism should not be avoided in the social and behavioral sciences but, rather, it should be encouraged; however, that encouragement should include the insistence upon the relevance of universal theories to the body of experimental and empirical data which is available for examination. The value of all theorizing rests principally upon the contribution made by it to the incremental accretion of universal generalizations. Short of this we may understand the parts better than we have in the past but we may not be far along in understanding the whole which is different from the sum of its parts. "To be sure, theory will not generate new laws by explaining old ones till we have old ones to be explained." (Kaplan p 303.)

> Knowledge grows not only by accretion and the replacement of dubious elements by more sound ones but also by digestion, the remaking of the old cognitive materials into the substance of a new theory. Hierarchial theories are typically improved by replacing some of their postulates by others, or by formulating a new set from which we can deduce the old one and other significant consequences as well. In the case of concatenated theories the pattern is sometimes extended, but more often it is changed in ways that reveal it to be a fragment of a larger and usually quite different pattern. The realization that some of the so-called "nebulae" are not really nebulous but enormously distant galaxies of stars in their own right not

only generated new conceptions of stellar universe, but also changed significantly the conception of our own Milky Way. (Kaplan pp 304-5.)

Kaplan argues that knowledge grows by way of <u>extension</u> and by way of <u>intension</u>. Growth by extension is the familiar building-block mode of learning. Thus subtraction follows addition and multiplication precedes division. "In growth by intension a partial explanation of a whole region is made more and more adequate." (Kaplan, p 305.) Extension and intension are involved in all advances in theory in that each additional increment would have to conform to a closed system of thought. In order to fit, its role would have to have been preordained much as a piece in a jigsaw puzzle will normally fit one and only one place in the puzzle. Kaplan quotes Hutten as saying that growth in science "is not simply adding on units to something already existing that remains unchanged in the process. The whole structure, the skeleton, changes with growth even though it remains recognizably similar to what it has been. The system of science would not be flexible unless its structure could change with increasing knowledge." (Kaplan, p 305-6.)

The principal significance of theory lies in the direction of providing guidance for action. " . . . the guidance which theory provides is chiefly and most directly for scientific activity--forming concepts and laws, conducting experiments, making measurements, providing explanations and predictions." (Kaplan, p 310.) These are the properties of theory and of scientific inquiry. The degree of formalization does not determine the scientific nature of an enterprise--that which is formalized may be more explicit and more precise lending itself to a greater degree of incrementalization in research. But formalized systems are not necessarily more suitable to theory and theorizing than partially formalized systems even though experimentation and observation may be more carefully controlled in the former.

> "Formalize as much as you can" might be sound advice if, e.g., the <u>only</u> goal of the scientist were the achievement of the most rigorous possible formulation of his theories. However, he is equally, if not more, concerned with a plurality of other goals, among them prediction, control, and the experimental testing of his theories. Attempts to acheive great rigor in the formulation of a theory may conflict with the achievement of some of these other goals. Furthermore, at a given stage of a theory's development insistence on great rigor may be stultifying; its premature achievement may even tend to constrict inquiry. Finally, the disproportionate allocation of scientific energies available to this one facet of the scientific enterprise

> might result in the neglect of other equally important aspects of that enterprise. Of course, these structures apply pre-eminently to the scientist who must be the initial formulator of scientific theory. They do not apply to the philosopher or logician who may be interested in the different task of rigorously reformulating theories. (Rudner p 52.)

Validation of theories.

Of critical importance is determining the validity of theories for certainly each theory is not as valid as every other theory. The question concerns how to decide which theories deserve to be or should be applied, published, exhibited, and investigated. The mere fact that a theory is adduced is not sufficient reason to warrant giving it major consideration. Philosophers of science talk of three types of norms which may be used to validate theories: Norms of correspondence or semantical norms, norms of coherence or syntactical norms, and pragmatic or functional norms.

We apply norms of correspondence in order to determine whether or not the theory fits the facts. A theory is true if it explains how things work and/or if predictions made on the basis of the theory are in fact fulfilled. Further, a theory must correspond to an informed or intelligent view of related data. It must make sense in terms of other theories and must jibe with that which we know. In other words the norms of correspondence seek to adduce that the theory conforms to the data and to previously formulated theories.

Norms of correspondence seek to determine whether or not a theory is capable of being integrated with related or relevant theories. If a theory stipulates a condition which, although plausible, can be accepted only if other theories are rejected, there is a prima facie case against the theory. Theories of telepathy are incapable of being integrated with theories of the transmission of information since telepathy is unaffected by distance which affects all other forms of transmission. The test of correspondence cannot disprove telepathy but it reduces it to a more speculative position and one which permits a scientist to reject it because of its inconsistency with other known theories.

The norms of coherence are simplicity and symmetry. The simplicity that is desired is both descriptive and inductive. Descriptive simplicity means that the description itself is presented in the simplist possible way. The more descriptively simple a theory the greater the convenience in handling it. Inductive simplicity is concerned with simplicity in what is being described and the extent to which it is achieved may promote the best development of the theory. The requirement of inductive simplicity does not mean reducing every inquiry to its most simple possible form; however, it means reducing the number of variables that are dealt with in the theory to the smallest number that do not do violence to that which is being described. As will be noted later, the application of some psychological theories deriving from the study of interpersonal behavior to international negotiation calls into question the norms of coherence in that too much simplicity is frequently introduced in the description of the bargaining process at the international level.

The justification might be given for the norm of simplicity that the norm does not condemn complexity but only imposes upon it the burden of proof. We are to introduce a complicated factor only if we have reason to expect error from its omission, and not if we just lack a reason for expecting error from the simpler treatment. On this interpretation, the norm of simplicity presents itself as another form of Occam's razor: variables are not to be multiplied beyond necessity. Here there is no metaphysical assumption about Nature's preferences, but an appeal to the same considerations of convenience that justify the choice of descriptive simplicity. Popper has urged an even stronger justification: the more complicated the theory the less it says, for the harder it is to falsify-- the more likely it is that something in the theory will either make recalcitrant facts irrelevant because they fail to satisfy certain conditions, or else reinterpret them so that they are no longer disconfirming. (The Marxist theory of history is a good example, I think.) "There is no need," Popper says, "for us to assume a

> 'principle of economy of thought' or anything of the kind. Simple statements, if knowledge is our object, are to be prized more highly than less simple ones because their empirical content is greater; and because they are better testable." All things considered perhaps the best methodological course as to the norm of simplicity is Whitehead's: "Seek simplicity and distrust it." (Kaplan, p 318.)

Theory should be esthetically appealing. The closer a theory can approximate symmetry, the more appealing it should be. This is not to argue that a theory should be judged in terms of its beauty but that the degree to which it has esthetic appeal is a measure of the precision, clarity, and simplicity that have been achieved.

Finally, theory should conform to certain pragmatic or functional norms. This is the test as to how effective it is for scientific purposes. A theory may be very useful insofar as its contribution to improving scientific procedures even if it does not improve the current state of scientific knowledge. This is not to argue for methodology for methodology's sake, but that if the theory that is developed improves our understanding of the discipline, it may make as signal a contribution to science as the knowledge itself would have contributed. Theory is heuristic. Indeed it may well be that the heuristic is the greatest contribution in that theory helps us to phrase questions more than to answer them. By means of theory, we are able to formulate hypotheses which are worthy of investigation, which promise to yield greater rewards for the inquiry. A theory provides an additional service in helping to explain old laws and to predict new ones. Thus theory can be used very effectively to reexamine previously studied information in an attempt to arrive at greater understanding of what occured and what might have transpired had some parts of the condition been different. "In the science of physics at least it would almost be more accurate to say that we believe our laws because they are consequences of our theories than to say we believe our theories because they predict and explain true laws!" (Campbell quoted by Kaplan, p 321.)

Models.

Much of international relations research in recent years has been concerned with building models which purport to represent the international system or portions thereof. Models of various types and styles have been employed with varying degrees of accuracy, appropriateness and utility. Six styles of models abound in the literature: First is the literary style which is represented by the great body of biographical and anecdotal literature including most of the materials available in diplomatic history, memoirs, and many of the published policy critiques. Examples of such literary modular materials would include Nicolson on diplomacy, (Nicolson, 1964.) (Iklé, 1964) on negotiation and the spate of studies of John F. Kennedy (e.g., Sorenson, 1965, Schlesinger, 1965). Journalists typically employ models of the literary style. Such models tend to be vaguely drawn, imprecise, and lacking in rigor; however, there is a narrative quality which generally eludes writers of more rigorous and carefully drawn models. Because of their lack of precision and their reliance upon linquistic as distinguished from symbolic elements in the model, literary models are less susceptible to replication and retesting than extra-linguistic models and hence have little to commend them in terms of the process of incrementally increasing understanding of international political processes.

The second style to be noted is the academic style. This is distinguished by way of being more abstract and more generic than models of the literary style. There is much more of an attempt at being precise but since the style is verbal it is no less ambiguous than the language. The precision that is sought in the academic style is verbal precision rather than operational precision--it seeks not to prepare the way for empirical validation. Hegel, Marx, Toynbee and Spengler employed the academic style in their historical systematizations, as did Adam Smith and Milton Freedman in their classical economics.

The third style is eristic in its requirement for the statement of specific propositions which are subjected to proof. The emphasis is upon "deductive relationships, logical derivations from propositions previously established or explicitly assumed, though proofs are sketched rather than rigorously laid out" (Kaplan, p 260.). Much of the work of behavioral psychologists as represented by Pavlov, Skinner, and Osgood, for example, is eristic in style. The eristic style depends upon the employment of experimental and statistical data for validation rather than relying upon verbal validation.

The fourth style is symbolic with its emphasis upon nonverbal devices for representation. The model is couched entirely in mathematical rather than linguistic terms and all work on the model is conducted symbolically rather than verbally. Econometrics, psychometrics, sociometrics, game theory, and decision theory represent symbolic styles of models. Among the various styles of models, the symbolic are the least ambiguous and the most precise. Riker's three-person game is a good illustration of the symbolic style as is Kent's model of bargaining. (Riker, 1967; Kent, 1967.)

Fifth is the postulational style which is in some respects a variant of the symbolic style. Where the symbolic style depends upon mathematics for its proof, the postulational style depends upon semantical logic.

> Emphasis is on the system as a whole, bound together by the chains of logical derivation. Rules for such derivations are explicitly formulated and applied. The foundation upon which the whole system is erected is a set of

> propositions laid down to serve in just this way: These are the postulates; often they are also called "axioms", though in more strict usages this term is reserved for postulates whose truth can be established without appealing to anything beyond pure logic and mathematics. In general, postulates have an empirical content, and their truth is dependent on matters of fact. From the postulates theorems are derived, whose verification indirectly validates the postulates by which they are proved. Interest centers on the independence of the postulates from one another (none of them is a theorem of the system constituted by the rest), and on their mutual consistency (a proposition and its negation cannot both be derived from the set). What is wanted is the simplest sets which will suffice for the derivation of the theorems in which they are interested, one which will allow for elegant proofs of the important propositions about the subject-matter. The postulational style is likely to be less demanding of the extensive measurement, less bound by various quantitative scales. (Kaplan, p 261.)

Morton Kaplan's <u>System and Process in International Relations</u> is an excellent example of the postulational style, as is Richard Rosecrance's <u>Action and Reaction in International Politics</u>. (Kaplan, 1957; Rosecrance, 1963.)

Sixth is the formal style which is similar to postulational but is not related to any specific empirical content. "The difference is that here the key terms are not given any interpretation; there is no reference to any specific empirical content. What is remarkable is that the validity of the derivations is not dependent upon any such content, but only upon the pattern of relationships holding among the symbols themselves--hence the designation formal." (Kaplan, 1964, p 262.) Newcomb's A-B-X phenomenal system model of communication is illustrative of the formal style, as is Fedder's derivative model of communication in negotiation. (Newcomb, 1958; Fedder, 1964.)

Of the various styles of models, it would appear that the eristic, the symbolic and the postulational have the most to offer to international relations theory. This statement holds true only if one agrees with the premise advanced earlier that scholarship and understanding are advanced as a function of incremental additions to the body of knowledge about international affairs. The scientific study of international relations depends upon accumulating studies which have empirical relevance and whose findings are transferable to other studies so that we can develop a body of lawlike generalizations which stand up to symbolic and logical testing.

Models are of utility if and only if they can contribute to an expansion of our understanding of a theory or process or of some phenomenon. The term has been used and (misused) in many ways but as I am employing it, a model is an artificial or abstract representation of a systemic relationship adduced by a theory. Rudner says that " . . . a model for a theory consists of an alternative interpretation of the same calculus of which the theory itself is an interpretation."[30] The model then must possess the same logical properties as does the theory; that is, it must be isomorphic to the theory. The model need not reproduce all of the conditions of the referent. The conditions that are important at this point are structural and not contextual.

In addition to being isomorphic to their referent systems, models can be isomorphic to one another. They are isomorphic if the structural properties in one model hold for the second model. The isomorphism that is required here is only in terms of the structural properties of each of the models and not with respect to how the systems behave. Conceivably, for example, a model of a molecule may be isomorphic to one of the solar systems. This does not say that a molecule behaves in a similar manner to the solar system but that the relationship among the various parts of the molecule is isomorphic to the relationships between the various parts of the solar model.

> More specifically models are isomorphs of one another. Both systems have the same structure, in the sense that whenever a relation holds between two elements of one system a corresponding relation holds between the corresponding elements of the other system. The systems need not stand in any casual connection,

> for what is required is only that the relations correspond, and to satisfy this requirement it is enough that we can put them into correspondence, that is think of them as corresponding. Then, whether a system does or does not show a certain pattern of its own internal relations is plainly quite independent of what the other system shows. If there is an isomorphism, the systems significantly resemble one another only in their structural properties, additional resemblances, if any, being irrelevant. (Kaplan, 1964, p 263-4.)

Analogies.

The isomorphism of a model is limited to the structural or logical properties of the system. If we want to compare the behavior of one model to another--that is to discuss similarities in the content rather than in the structure, we are concerned with the analogical as distinguished from the logical characteristics of the system. Where models are concerned with structure, analogies are concerned with behavior. Analogies may be drawn even where the models are quite dissimilar. Analytically, we might discover that a system or a part of a system exhibits a behavioral pattern that is isomorphic to the behavioral pattern of another system or part of a system.

> To take an example, the assertion that an automobile eats gasoline can be taken to be purely metaphorical.

> But in a certain sense it is literally true, because the burning of gasoline liberates energy which propels the car in quite the same way as the oxidation of food liberates energy which activates the muscles.
>
> Comparison of social and political systems to living organisms has been frequently dismissed as metaphorical and naive. But this is so only if the sole purpose of the comparison is to evoke a suggestive image. If real isomorphisms can be traced between the functioning of living organisms and of political systems (e.g., self-maintenance, growth, evolution) then the comparison is more than allegorical. It carries elements of real "homologies" quite as the analogy between an engine burning fuel and an organism digesting food. (Rapoport, 1966 p 139.)

The analogy in this illustration holds because the essential properties with which we are concerned are present in both cases--in the oxidation of food to provide energy and in the burning of gasoline to provide energy. If the relational properties were not isomorphic, no analogy would exist. The great difficulty presented by Dean Rusk's assertion that the situation in Vietnam in the mid 1960's was analogous to the situation in Europe in the late 1930's rests precisely in the lack of relational isomorphism of the two situations. It is not enough to assume that since there are some apparent similarities in two situations, that an analogy may be drawn. The analogy is valid if and only if the behavior exhibited is isomorphic in fact and not that it approaches isomorphism or that there are some isomorphic features that are present.

An additional limitation in the use of analogy must be asserted. An analogy (or a model) can only explain the analogy (or the model). The dynamic relationship between A and B, for example, may be discovered to be analogical to the behavior between C and D. But knowing that A and B behave in a certain fashion does not tell us that C and D behave in the same way. Analogy will not stand in place of empirical or experimental research. On the basis of empirical and experimental research we may find that analogies exist. Having discovered analogies between two models or two systems, we can formulate hypotheses which when investigated may lead to the discovery of further analogies. Thus analogies and models perform the heuristic function of helping to prepare for further scientific research. Neither models nor analogies can prove anything concerning the structural or behavioral properties of their referents, just as a laboratory experiment cannot prove a theory. They can, however, demonstrate that certain structural or behavioral properties are manifest in the referent so that we can say that "since the model behaves in this fashion it is reasonable to expect the referent system to behave in the same fashion since it is isomorphic to the model."

As heuristic devices, analogies can assist the social scientist in explaining and predicting social and behavioral phenomena; however, analogies cannot form the basis for such explanation and prediction. By way of analogy, he may discover new avenues of investigation and fresh approaches to the solution of his problem, but the hard content of explanation of behavior must develop from observation or testing of the behavior itself. And predictions must develop out of the past experience of phenomena. The development of policy prescriptions based upon explanation and prediction arising out of analogy is always dysfunctional and is potentially catastrophic. Knowing that the human digestive system requires significant quantities of water to perform its functions, the adding of significant quantities of water to an automobile's gasoline tank would not be indicated. Similarly, even if there were an analogy between Vietnam in the mid 1960's and Central Europe in the late 1930's, the policy responses adopted in the latter would not on that account apply in the former.

The social scientist must steel himself against the temptation of substituting analogy for inquiry, and substituting a model for reality. At the risk of being repetitious, it is clear that the correct employment of models and analogies facilitates research in four ways: First, they help us identify and organize relevant data and discard irrelevant data. Second, as a function of their explicitness, they permit researchers to build upon and criticize work of preceeding researchers, thereby promoting incrementalism. Third, they encourage the development of explicit definitions of concepts in a manner that minimizes vagueness and ambiguousness. And fourth, they promote the framing of postulates and hypotheses which can be measured, tested, classified, etc., thereby facilitating their confirmation or disconfirmation.

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