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THE APPLICABILITY OF TORGERSON'S CONCEPT OF FIAT MEASUREMENT

IN DEVELOPMENTAL STAGES OF THE SOCIAL SCIENCES

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The concept of "fiat measurement" is an alternative to fundamental and derived measurement. This concept is believed to be more descriptive of measurement in the social sciences, where in most cases theories as well-formed as those in the physical sciences do not exist. In fiat measurement an index or measurement of a concept is assumed to be representative of that concept. However, the representation between a measurement scale and the theoretical concept cannot be proven. Although fiat measurement is descriptive of much current work in social sciences, it is shown to be a problematic concept because of its arbitrariness, lack of foundation in theory, and non-confirmability. The nature of theories and the relations of measurement to scientific theories are discussed. The use of fiat measurement is related to a prescientific state of some of the social sciences. Before better forms of measurement can be used, considerable theoretical development is necessary in these sciences.

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MEASUREMENT CLASSIFICATION SYSTEMS

The purpose of this paper is to investigate the nature of fiat measurement and to characterize its place in scientific theories of developmental-stage disciplines. Two major measurement-classification systems will be briefly surveyed to determine where fiat measurement fits. This is followed by consideration of the general structure of theories in order to characterize fiat measurement more formally. Finally, several examples are given.

Two primary classification systems have been developed to describe measurement. First, Campbell (1928) recognized two kinds of measurement: fundamental and derived. His system is descriptive of kinds of measurement used in the physical sciences, but it has often been extended to the social sciences. Campbell's system is based on whether or not a particular measure depends on any prior measurement.

Fundamental measurement depends on no prior measurement. Practically, only a few properties, such as length, time, value, numerosity, and mass are fundamentally measurable. Derived measurement depends on the prior measurement of fundamental magnitudes and is descriptive of measures such as density and acceleration.

Campbell's classification system of measurement fits well in the more mature sciences. Whereas physical sciences such as physics and chemistry are well developed and have explicit structures, many of the social sciences do not. When Campbell's structure is extended in an attempt to describe social science measurement, problems arise with the disciplines which are in earlier stages of development, or which are "prescientific." In the social sciences there are few examples of fundamental or derived measurement. One objective of this paper is to discuss this paucity and to link it to the status of the development of social science theories.

A second major measurement-classification system was developed by Stevens (1959:18-36), a social scientist. Stevens' system is based on the types of measurement scales which are used. He identified five scale types: nominal, ordinal, interval, ratio, and logarithmic interval scales. The basis of his system is the type of transformation that leaves the scale form invariant. It is Stevens' system which is usually used when social science measurement is discussed.

While Stevens' system is descriptive of the classification of scalings used in the social sciences, it does not shed light on issues such as the meaning of measurement scales in relation to abstract theoretical concepts. Although Stevens' system will classify measurement scales according to their mathematical properties, it does not deal with the question of whether or not they are artificial constructs. That is, it will define an intelligence scale as being an interval scale, but not whether an intelligence test actually measures intelligence. Thus, a second objective is to analyze the theoretical

importance of measurement scales and the properties which they measure.

Suggestions have been made by several authors for expanding these measurement-classification systems, notably Coombs (1952), Ellis (1966), and Torgerson (1958). Their aim has been to establish the characteristics which are necessary to classify a scaling technique or numerical-assignment technique as measurement. With this in mind, Torgerson (1958: 21-24) added to Campbell's system a third kind of measurement, which he called *fiat measurement*. In fiat measurement, the associative relation between the property to be measured and one or more observable properties which serve as indices of it is somewhat arbitrarily defined. The measurement of the observable property is considered an index of the underlying non-observable property. This is similar to Ellis' (1966:56) concept of associative measurement, which he considered only to be possible if "there is an independently measurable quantity, q, associated with the quantity, p, to be measured, such that if things (under certain specified conditions) are arranged in the order of q, they are also arranged in the order of p." The arbitrary nature of the measurement emerges because, if the underlying concept is non-measurable, then the establishment of the correspondence between the ordering of the two properties is not factually demonstrable. This type of measurement is represented by measures of intelligence, hunger, and social status. Although far from ideal, these types of measurements continue to find use in the social sciences because the underlying non-measurable properties have utility, and because none of the more preferable measures is yet possible.

GENERAL STRUCTURE
OF THEORIES AND MEASUREMENT

An understanding of the essential place of measurement for the confirmation and predictive ability of theories holds promise of adding insight to problems of measurement in the social sciences. To this end, it is necessary to discuss the structure of scientific theories, and then to ascertain the nature of measurement in relation to theories.

A scientist examines a particular aspect of the world, or domain, with generally three objectives: to discover general regularities which explain the phenomena which he observes (general laws), to make predictions, and to control or influence the relevant domain in the environment. The objectives must proceed in order. To discover general regularities, the scientist abstracts the most important elements of the domain, or selected portion of the environment. These basic elements are the theoretical terms, which through induction are stated in axioms of the system. The axioms state the important relations between these elements. In the axiomatic-deductive method, these basic elements and relationships form a mathematical or formal model, which is intended to be descriptive

of the domain. Mathematical or logical calculi are then applied to this basic model to deduce as complete a description of the structure of the domain as is necessary and practicable.

This basic model is used, through deductive reasoning, to derive testable hypotheses, predictions, and normative statements (especially in the case of the social sciences). A well-formed theory must be logically consistent, its logical structure should not be redundant, and it should be complete in the sense that it must be possible to derive a statement describing all essential characteristics of the subject matter. A theory is not complete if it cannot provide sufficient predictions and explanations. As well as satisfying these three formal criteria, a theory must be factual, or confirmable. Hypotheses generated from the model should be testable, and these tests must indicate that they are not contrary to fact. To these traditional criteria of scientific theories, it is well to add a fifth which is of importance especially in the social sciences: the criterion of social usefulness. A social theory must be evaluated in terms of its usefulness in establishing policy or making decisions.

Theories which contain testable hypotheses are said to have empirical content. Empirical content is added to a theory by interpreting the formal structure in order to ascertain if the structure yields realistic propositions. Any formal structure which purports to describe the domain is a model, but a model only becomes a theory when empirical confirmation is added.

Figure 1 illustrates, in a simplified sense, the relationship between axiomatic theory and the domain of the real world to which the theory applies.

The mathematical conclusions are hypotheses which, when interpreted, must not contradict observations in the real world; these are actually predictions concerning objects
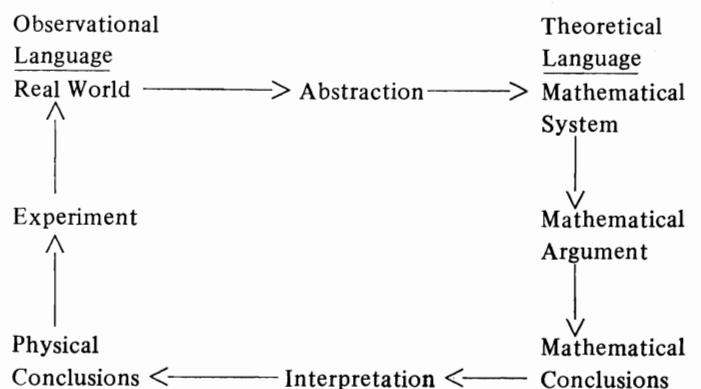

FIGURE 1. Scientific investigation (adapted from Coombs, Raiffa, and Thrall, 1954:133).

and properties in the domain. A test of such a hypothesis amounts to matching the mathematical conclusions against physical events. If correspondence is found, the theory is said to be confirmed. If none is found, the theory is not confirmed, and it is merely a formal structure without interpretation. Such a structure is useless in any discipline which needs useful predictions and general rules to apply to empirical situations.

Measurement theory relates to theory construction in that measurement is the strongest form of correspondence. Whereas in the tests of hypotheses with which we have been concerned correspondence between the real world and the structure of the theory was needed, in measurement the correspondence is an exact numerical one. Instead of the correspondence between theory and domain being qualitative, the correspondence mirrors the ordering of events in the real world in a very strictly determined way.

FIAT MEASUREMENT

Classification of a measurement as fiat measurement rather than as some higher form of measurement seems attributable to two potential problems within a theory which is not well-developed:

1. The nature of the relationships among the theory's theoretical terms may not be well-established, or

2. The nature of the relationship between the theory's theoretical and observational terms may not be well-established.

Several possible combinations of these relationships are shown in Figure 2. The solid arrow indicates a relationship that is well-established, and the wavy arrow indicates a fuzzy one. Terms which have been used to describe these are *constitutive significance* and *epistemic significance* (Dumont and Wilson, 1970).

Constitutive significance refers to the nature of the relationships among the theoretical terms or Theoretical Vocabulary, V_T, of a theory and relates primarily to its explanatory power. This relationship can be relatively strong or weak. When strong, the theory's explanatory power is strong, with some of the assumptions of the theory having achieved the status of scientific laws. When relatively weak, the explanatory power of the theory is weak.

Epistemic significance refers to the nature of the relationship between observable terms or Observational Vocabulary, V_O, and theoretical terms, V_T, of a theory and relates primarily to its predictive power. This relationship can be well-established (when representation is proved) or fuzzy, when it is arbitrarily assigned.

As Figure 2 shows, a theory in a mature science has both epistemic and constitutive significance. The logical relations between the theoretical terms are well-established, and the correspondence rules between theoretical and observational terms are empirically justified. The mapping representation in the measurement function has been empirically verified. In those theories classified as less well-developed, either constitutive or epistemic significance is absent, or in some cases both are not well-established. In a pre-scientific discipline, the epistemic significance may be vaguely conceived. That is, the relations between theoretical terms or between theoretical and observational terms may be approximately known, but not exactly well-defined. If constitutive significance is absent, the contribution of theoretical terms to explanation and prediction is not empirically verified. Progression from a pre-scientific discipline to a mature science involves improving the status of terms and relations through logical analysis and empirical verification.

Several hypothetical examples of social science measurement are also shown in Figure 2. The measurement of depreciation is a case in which a given income concept (such as economic income) leads to a well-defined depreciation concept (such as economic depreciation). However, economic depreciation is not in many cases an operational concept. Thus, although the relation between the theoretical terms and the properties to be measured is well-defined, the mapping representation cannot be established exactly.

In measuring intelligence, problem-solving ability and vocabulary, as well as other properties, might be assumed to be related to intelligence, but this cannot be proven. However, the mapping function between problem-solving ability and the intelligence test is verified. In this case the relationship between the theoretical term and the property to be measured is not well-established, whereas the mapping representation is well-established.

In the pre-scientific measurement of social status shown in Figure 2, it can be seen that both types of relationships are weak. Social status is assumed to be somewhat related to upward mobility, which in turn, is assumed to be related to salary. However, these relationships cannot be substantiated beyond statistical tests of significance.

CONCLUSIONS

Social science theories which employ fiat measurement are useful since they provide a more formal way of looking at phenomena: they provide at least a starting point for developing a science. Fiat measurements certainly are not as desirable as fundamental and derived ones because of the lack of verification of relationships between indices and theoretical concepts. Fiat measurement leads to the danger of scientific relativism, because factual truth cannot be verified.
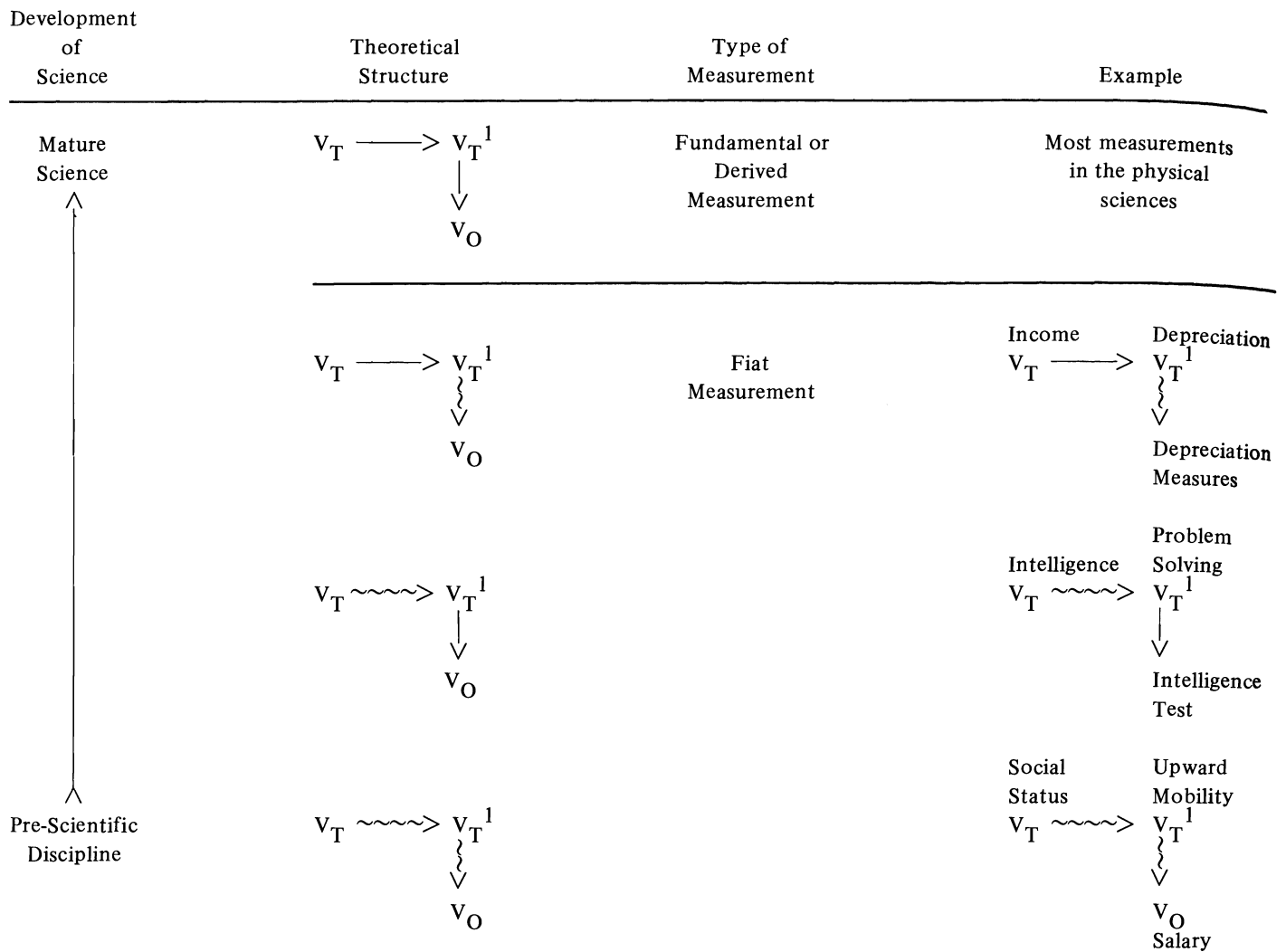
Development of Science	Theoretical Structure	Type of Measurement	Example
Mature Science $\wedge$	$V_T \longrightarrow V_T^1$ $\downarrow$ V_O	Fundamental or Derived Measurement	Most measurements in the physical sciences
	$V_T \longrightarrow V_T^1$ $\rangle$ V_O	Fiat Measurement	Income $V_T \longrightarrow$ Depreciation V_T^1 $\rangle$ Depreciation Measures
	$V_T \rightsquigarrow V_T^1$ $\downarrow$ V_O		Intelligence $V_T \rightsquigarrow$ Problem Solving V_T^1 $\downarrow$ Intelligence Test
Pre-Scientific Discipline	$V_T \rightsquigarrow V_T^1$ $\rangle$ V_O		Social Status $V_T \rightsquigarrow$ Upward Mobility V_T^1 $\rangle$ V_O Salary

FIGURE 2. Measurement and the development of sciences. (V_T = Theoretical Vocabulary; V_O = Observational Vocabulary.)

Fiat measurement is, however, descriptive of measurement as it is performed in many of the social sciences. Fiat measurements do provide refinement of knowledge which can lead to a clarification of epistemic and constitutive significance. When this clarification proceeds to the point that the science has both epistemic and constitutive significance, the discipline has evolved into a mature science. Then measurement in the classical sense is possible.

John Dewey (1938:345) quoted Charles Peirce's expression of a similar idea: "Truth is that concordance of an abstract statement with the ideal limit towards which endless inquiry would tend to bring scientific belief."

REFERENCES

Campbell, N. R. 1928. *An account of the principles of mea-surement and calculation.* London, Longmans, Green and Company, Limited: 293p.

Coombs, C. H. 1952. A theory of psychological scaling. *Engineering Research Bulletin No. 34.* Ann Arbor, Michigan, Engineering Research Institute, University of Michigan: 94p.

_____ , H. Raiffa, and R. M. Thrall. 1954. Some views on mathematical models and measurement theory. *Psychological Review,* 61:132-144.

Dewey, J. 1938. *Logic: the theory of inquiry.* New York, Henry Holt and Company: 546p.

Dumont, R. G., and W. J. Wilson. 1970. Aspects of concept formation, explication, and theory construction in sociology.

In D. P. Forcese and S. Richer (eds.), *Stages of social research.* Englewood Cliffs, New Jersey, Prentice-Hall: 40-53.

Ellis, B. 1966. *Basic concepts of measurement.* New York, Cambridge University Press: 220p.

Stevens, S. S. 1959. Measurement, psychophysics and utility. *In* C. W. Churchman and Philburn Ratoosh (eds.), *Measurement: definitions and theories.* New York, John Wiley and Sons: 18-63.

Torgerson, W. S. 1958. *Theory and methods of scaling.* New York, John Wiley and Sons: 460p.