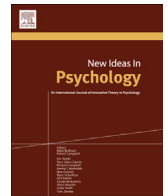


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Behavioral science integration: A practical framework of multi-level converging evidence for behavioral science theories

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A B S T R A C T

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Several frameworks exist to help science in organizing known information, connecting previously disparate phenomena, promoting understanding, and identifying gaps in knowledge. This paper integrates previous frameworks that have been used in the behavioral sciences to produce a more comprehensive, specific, and complete framework, consonant with the process of scientific discovery as based on multiple, independent, and converging lines of evidence. This *multi-level convergence framework* is designed specifically for the analysis and understanding of human cognitive/behavioral traits, in contrast to more general frameworks that are designed to be applied relatively widely (such as across all information processing systems or across all biological organisms). This integrated framework overcomes gaps in prior frameworks, provides a more complete picture of the interrelationships between various aspects of the behavioral sciences, and can aid in evaluating theories, both for comparison and identifying gaps in evidentiary support.

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1. A practical framework of multi-level converging evidence for theories in the behavioral sciences

What allows some scientific fields to advance seemingly by leaps and bounds, whereas other sciences progress by fits and starts or even at times regress? Certainly there can be many factors, but the particular concern of this paper is an impediment of progress due to the lack of a consistent, enduring, and comprehensive framework for organizing and understanding research findings. Some behavioral sciences, in particular, have a tendency to cycle through a parade of zeitgeists (e.g., functionalism, structuralism, behaviorism, relativism, subjectivism, etc.), each enjoying only transient popularity. As a result, there is considerable wasted effort, amnesia for older research results, and a lack of enduring scientific progress. The objective of this paper

is to develop a consistent, comprehensive, and enduring framework for research in the behavioral sciences.

The starting point for this paper is the principle of scientific realism: the presumption that all the different areas of science are in fact studying a single, real universe. Although a few perspectives, such as constructive relativism, may not accept scientific realism as a basic fact, it is otherwise almost universally acknowledged – particularly among researchers—and a foundation for certain tenants of the scientific method (e.g., testability). Scientific realism has implications for how different areas of science are related to each other. First, it is required that no sciences directly conflict with one another. Given a single universe, there cannot be two correct scientific explanations that fundamentally contradict each other. Second, scientific realism further requires that different bodies of knowledge must be consistent with one another if they are overlapping. It is acceptable for two fields of knowledge to merely be non-contradictory if they have no overlap (e.g., quantum physics and social psychology quite possibly have

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no overlap, hence there are no contradictions and no opportunity to ask about consistencies). When two areas do overlap, however, the shared knowledge and understanding of the world must be consistent.¹

In many areas of science, this principle of fundamental consistency has been effectively and powerfully realized. The physical sciences such as chemistry, physics, geology, and astronomy are organized and integrated relative to each other, yielding tremendous advances in knowledge and coherence. Information from any one field provides guidance (and boundaries) for any other field in terms of what is likely, possible, and impossible. The social sciences have had more difficulty reaching a substantial and sustained integration, and this has hampered advances in knowledge and coherence.

This is not to say that no integration has occurred within the social and behavioral sciences. The cognitive science approach represents a fairly successful integration of specific fields (primarily computer science, neuroscience, and cognitive psychology). Similarly, the evolutionary psychology approach has tried to integrate a slightly different set of fields (primarily evolutionary biology, psychology, and anthropology; [Pinker, 1997](#)). Both these approaches have so far experienced both unfulfilled potential and stalled progress for various reasons. This paper suggests that part of the difficulties these approaches have experienced has to do with the particular frameworks and fields included in each approach. Perhaps somewhat paradoxically, these ambitiously integrative approaches were in certain respects too narrow. An integration of the behavioral sciences, following the principle of scientific realism, needs to include more than three or four fields.

How should we conceptually organize the many research disciplines that make up the behavioral sciences, though? It is, from one perspective, an *ill-defined problem* ([Simon, 1973](#)): A problem with ambiguities in the initial starting state, the permissible operations relevant to that problem, and the desired goal state. Most real-world problems are ill-defined to some degree ([Simon, 1973](#)). (This is in contrast to artificial problems, such as most invented games, in which the starting states, permissible moves, and goal state are clearly defined in the rules of that game.) So we need some sort of structure to organize efforts at integrating the behavioral sciences and achieving consistency. Such structures and frameworks have been proposed, in various fields and at various times, to organize findings and even organize fields relative to each other. The following sections review a number of these and note their individual strengths and weaknesses. Two overarching themes can be discerned from these organizing frameworks: a) principles of converging operations, and b) multiple, complementary levels of analysis. Interestingly,

these two themes have developed largely along parallel tracks and have not been particularly well integrated with each other. Thus, after reviewing these past frameworks, we will construct a framework that integrates these two major approaches to organizing and evaluating scientific knowledge. This multi-level model of converging operations seeks both to retain the strengths of prior frameworks and to leverage aspects of different frameworks to overcome some of their individual weaknesses.

2. Convergence frameworks

There is a general approach, often learned through gradual inculcation, that much of scientific progress is based on *multiple, independent, and converging lines of evidence*. Theories and hypotheses that repeatedly find support across various studies, researchers, fields, and methodologies (which includes surviving attempts at refutation) are seen as better approximations of the true state of the world, whereas hypotheses and theories that fail to find support across one or more of these lines are seen as inferior and eventually discarded. One way to think about this approach is that it parallels the narrower concept of convergent validity in research methods, in which a proposed measure of a construct is validated by finding that it correlates with other known measures of that same construct. (One can also conceptualize this process as a Bayesian model for scientific reasoning; e.g., [Howson & Urbach, 2006](#).)

The idea of “converging operations” in psychology—using multiple studies to triangulate and validate a particular research finding—traces back to the perception work of [Garner \(1954\)](#) ([Garner, Hake, & Eriksen, 1956](#); see also the philosophical work on consilience by [Whewell, 1847/1967](#)). Garner was clear from the onset:

Validation can be obtained by using converging operations to arrive at a single construct or concept. If two or more independent sets of data, involving basically different indicators of the nature of the sensory process, lead to the same sensory scale, then we have a form of validation. Such validation is probably the only meaningful kind in this and in other areas of psychology. All valid concepts are formed from independent observations and operations which allow convergence to the single concept, although most techniques of validation used in psychology (with the obvious exception of factor analysis) do not make this process obvious. ([Garner, 1954](#), p. 223)

This has been expanded, as foreseen by Garner, to a more general approach. The rationale for this generalized version of the principle of converging operations was summarized by [Sternberg and Grigorenko \(2001\)](#) (see also [Sternberg, Grigorenko, & Kalmar, 2001](#)) in a powerful appeal for its use:

The basic idea is that any one operation is, in all likelihood, inadequate for the comprehensive study of any psychological phenomenon. The reason is that any methodology introduces biases of one kind or another, often of multiple kinds. By using multiple converging

¹ These implications of scientific realism lead to several topics and issues within philosophy. Some of these are consistent with the present paper (e.g., unity of science, consilience, and inference to the best explanation; [Whewell, 1847/1967](#), see also a more expansive treatment by [Wilson, 1998](#)), whereas others are less clearly supported or not endorsed at all (e.g., reducibility of scientific fields). The focus of this article, however, is on developing a useful working framework for research; not delving into these philosophical issues.

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