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The Science of Research Synthesis: An Empirical Foundation for Future Research in the Social, Behavioral, and Economic Sciences

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Abstract

Scientific methods of research synthesis are well developed but under-utilized in the social, behavioral, and economic (SBE) sciences. Scientific approaches can be applied to all of the steps in the research review process. Rigorous efforts to locate, analyze, and synthesize results of previous studies will provide more robust answers to questions about "what we know and what we don't know," and can provide useful empirical foundations for future research in the SBE sciences. The science of research synthesis can transform and propel the SBE sciences, but changes in current norms, infrastructure, and capacity will be needed to support this transformation.

1. *The challenge question: How can evidence from the social, behavioral, and economic sciences be cumulated scientifically?*

In recent years there has been great emphasis on identifying "what we know and what we don't know" on a wide range of topics in the social, behavioral, and economic (SBE) sciences. Accurate summaries of empirical research in these areas may have important policy implications and are essential for setting a coherent agenda for future research that will truly advance knowledge.

In general, we use scientific methods because we know that casual and unsystematic observations are unreliable. Thus, scientists take great care to use representative samples, valid measures, and replicable procedures in primary research. But science is cumulative, and the basic principles of science that are commonly used in primary research also apply to the synthesis of results across studies. Great care is needed to identify unbiased samples of relevant studies, conduct reliable assessments of methodological features and other important qualities of those studies, and accurately synthesize results across studies. Scientific methods of research synthesis exist, but scientists rarely cumulate evidence scientifically (Chalmers, Hedges, & Cooper, 2002).

When summarizing a body of evidence, many SBE scientists rely on their tacit knowledge or impressions of the literature. Experts often cite one or a few studies to support their views about "what we know" and "what works." Selective citations are likely to be misleading; hence, careful syntheses of all relevant evidence are needed to support statements about what we know and don't know. However, most published research reviews, best evidence syntheses, and meta-analyses in the SBE sciences fall far short of

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current, international, inter-disciplinary standards for research synthesis. Many published research reviews are deeply flawed because they rely on convenience (non-representative) samples of published studies, narrative summaries of selected studies, and the use of "cognitive algebra" to sum up results (Littell, 2008). Recently published meta-analyses in the SBE sciences also rely on convenience samples of published studies and out-dated synthesis methods. It is clear that expert opinion, traditional research reviews, and stand-alone meta-analyses are vulnerable to well-known sources of bias and error in the reporting, dissemination, and synthesis of research results. The science of research synthesis addresses these issues.

Scientific approaches to research synthesis have evolved over the last century, with rapid advancements in the last two decades, yet most SBE scientists are unfamiliar with the principles and methods of research synthesis. The scientific approach treats the review process as a legitimate form of research and follows the basic steps in the research process, taking precautions to reduce bias and error at each step. Central questions or hypotheses are needed to guide a rigorous research synthesis. Key constructs are defined, explicit study eligibility criteria are articulated, and detailed plans (protocols) are developed in advance to guide the identification, analysis, and synthesis of relevant data. Search strategies include efforts to find eligible studies that are unpublished or otherwise difficult to locate. Data are extracted from studies in a structured format, using multiple observers and inter-rater reliability checks. Formal assessments of methodological qualities and other important study features are planned in advance and conducted accordingly. When possible, meta-analysis is used to assess overall trends, variations (heterogeneity) across studies, possible sources of heterogeneity (moderators), and the likelihood of publication bias and other biases in a set of studies under review.

International, inter-disciplinary standards for research synthesis were established (by the PRISMA group and the Cochrane Collaboration) to minimize bias and error in research reviews. These standards are based on evidence from methodological research on the design, conduct, reporting, and dissemination of primary research and research reviews (much of this methodological research is contained in The Cochrane Library).

Systematic reviews are far more common in the health sciences than in the SBE sciences, but there are wide variations in the rigor of systematic reviews on health topics. Many of the systematic reviews conducted in the USA do not meet international standards. The most rigorous systematic reviews in the health sciences are conducted in the Cochrane Collaboration. The Campbell Collaboration provides a parallel framework for reviews in the SBE sciences.

Rigorous research syntheses should be conducted both at the beginning and at the end of any major research initiative to identify the need for new research and place results in their proper context. (At present, the UK National Health Service requires a systematic review of available evidence before funding new clinical trials.) Re-analysis of the review data are needed to assess the contributions of new studies and ensure that research syntheses are kept up to date.

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More rigorous research syntheses in the SBE sciences will benefit society in many ways. First, rigorous reviews can provide more comprehensive and accurate summaries of what we already know, including more accurate and reliable answers to questions about "what works" and "what works best for whom." Second, these answers may challenge prevailing views of the state of the SBE sciences, views that currently have a strong influence on social policy. Indeed there is evidence that expert opinion and traditional research reviews have lead to the wrong conclusions in some fields (Littell, 2008). Third, rigorous syntheses will lay the groundwork for future research by pinpointing gaps in knowledge.

The science of research synthesis can transform the SBE sciences by clarifying the current state of knowledge in many fields, identifying important gaps in knowledge, and providing an important structure for cumulating evidence as it is generated. However, changes in norms, infrastructure, and capacities of SBE scientists will be needed to bring this about.

Following the lead of the World Health Organization and others, we need to establish systems for ensuring that the public has unfettered access to research results through prospective registries of protocols for trials and other studies, access to raw data as needed, and full disclosure of possible conflicts of interest. Institutional Review Boards should insist on prospective registration, data sharing, and public disclosure of conflicts. Following the lead of the top medical journals, SBE journal editors should require compliance with these expectations as a condition of publication. Further training is needed so that SBE scientists have the knowledge and skills to conduct systematic reviews and meta-analyses in their areas of expertise

We cannot rely on expert opinion, tacit knowledge, traditional research reviews, or meta-analyses of biased samples of studies to guide important policy and research agendas. Government, private funders, and scholarly journals must demand and support more rigorous research syntheses.

2. Recent research and standing questions in the field

Many government and professional organizations have funded reviews of research on "what works" in psychosocial services, education, crime and justice, and welfare economics, to name just a few SBE fields. Available summaries tend to highlight results of selected, published trials, and many of these summaries are written by the same people who developed and tested the interventions in question. These are not comprehensive or unbiased appraisals of the relevant evidence. Although many SBE scientists are certain that we already know "what works" in some fields, a hard look at the evidence suggests otherwise (e.g., Littell, 2008).

There is ample evidence of outcome reporting bias, publication bias, and other dissemination biases in biomedical research (Song et al., 2009). Although there is no reason to believe these patterns are fundamentally different in the SBE sciences, there is scant evidence on reporting, publication, and dissemination patterns in SBE fields. It appears that these patterns are somewhat different in ecology than in biomedical research, so it is

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possible that reporting and dissemination patterns are different in the SBE sciences. The point is that we don't know whether the dissemination of research in SBE sciences is a biased process, as it is in biomedicine. Hence there is need to investigate reporting, publication, and dissemination patterns in SBE fields.

3. Disciplines that may contribute

The science of research synthesis has been developed by international, multi-disciplinary groups of scholars, many of whom are involved in the Cochrane Collaboration, the Campbell Collaboration, and the Society for Research Synthesis Methodology. Members of these groups come from many disciplines including psychology, sociology, economics, education, criminology, political science, anthropology, library and information sciences, statistics, philosophy, medicine, nursing, genomics, cognitive neuroscience, ecology, and climate sciences. Multi-disciplinary teams have produced systematic reviews and meta-analyses of a wide range of topics in these areas. All SBE disciplines may contribute to the development and application of the science of research synthesis.

4. Implications for future research

There is urgent need to investigate and (if necessary) reduce bias and error in the reporting, dissemination, and synthesis of research in the SBE sciences.

Current synthesis methods. Relatively little attention has been paid to the methods that have been used to synthesize results across studies in the SBE fields. Many influential research reviews have not used transparent methods; hence, further investigation of current practice is warranted. Future research should examine the extent to which recently published and influential reviews adhere to international, interdisciplinary standards (e.g., PRISMA). Are these reviews informed by the science of research synthesis? Do they adequately deal with sampling, data analysis, and synthesis problems? Are they vulnerable to bias and error?

Better synthesis methods. There is need for development, testing, and applications of newer (scientific) methods of research synthesis in the SBE sciences. Given the biases that are rife in nonsystematic research reviews, it is likely that scientific syntheses will fundamentally alter our understanding of what "we know and don't know." New syntheses of existing studies may lead to important discoveries, including better understanding of the essential (or common) elements of effective SBE interventions and policies, and the differential effects of interventions and policies for different subgroups.

The nature and extent of reporting, publication, and dissemination biases in the SBE sciences. Following the lead taken in biomedical research, cohort studies are needed to assess the extent of outcome reporting bias, publication bias, and dissemination biases (e.g., citation biases) in the SBE sciences. Song and colleagues (2009) demonstrate the analysis of several types of cohort studies, following research protocols from inception, registration,

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presentation at conferences, and manuscript submission to later publication and citation of results. Similar studies are needed in the SBE sciences.

Infrastructure and incentives to reduce reporting and dissemination biases, improve access to data, and reduce bias and error in research syntheses. What are the best ways to reduce bias and error in the reporting, dissemination, and synthesis of research results? Research is needed to assess the impact of efforts to encourage prospective registration of new studies (including full disclosure of data collection protocols), access to raw data, and full disclosure of potential conflicts of interest.

Building capacity for research synthesis in the SBE sciences. The need for training and technical assistance in methods of research synthesis is widely recognized around the world. At present, the international Cochrane Collaboration and Campbell Collaboration cannot keep up with demands for training and technical assistance. There is need for evaluation of training and capacity building efforts, to assess the best models and optimal timing of training initiatives. Graduate schools in the SBE sciences are beginning to offer courses on research synthesis, and workshops are provided by numerous nongovernmental organizations around the world.

The National Science Foundation could take the lead in developing an agenda for future research in the social, behavioral, and economic sciences that is informed and aided by the science of research synthesis. This can provide firm foundations for policy and future research.

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