Research synthesis: Diffusion, adaptation, and impact

Laura Sheble
TABLE OF CONTENTS

INTRODUCTION ............................................................................................................. 3
   PURPOSE, OBJECTIVES, AND RESEARCH QUESTIONS ......................................... 4
   SIGNIFICANCE ........................................................................................................... 5

LITERATURE REVIEW .................................................................................................. 7
   INTRODUCTION ....................................................................................................... 7
   RESEARCH SYNTHESIS ......................................................................................... 7
   FUNCTIONS OF REVIEWS AND RESEARCH SYNTHESSES .................................... 13
   DIFFUSION OF INNOVATIONS ............................................................................... 15

BIBLIOGRAPHY ............................................................................................................. 23
INTRODUCTION

Research synthesis, also called systematic or integrative review, sometimes referred to as meta-analysis, is a family of document-based research methods in which primary research reports are analyzed in a transparent and, generally, systematic manner, with the goal of generating new knowledge or interpretations. Proponents of traditional, post-positivist forms of research synthesis argue that through applying a scientific method to select, evaluate, and integrate findings from primary research, the findings of research syntheses support more objective interpretations of what is and is not known about a given research problem. Skeptics suggest the limitations in how research synthesis is used; limitations related to the types of primary research designs that can be included in the most prevalent types of research synthesis, and the exclusion of expert knowledge derived from practice and experience in the world limit the applicability of this approach as a replacement for traditional reviews. Further, in contexts in which research synthesis is viewed as the preferred method of review, it may be argued that knowledge, evidence, and understandings gained through methods or processes other than those congruent with accepted approaches to research synthesis is, at best, ignored; at worst, delegitimized.

The politics of knowledge notwithstanding, research synthesis has changed approaches to research integration within and at the boundaries of many fields of science following its emergence as a systematic method to combine and review findings of primary research studies in the 1970s. Researchers in psychology and education formalized methods of research synthesis, first as meta-analysis (Glass, 1976), and later, integrative or systematic research review (Cooper, 1982), in response to challenges associated with integrating research findings, theory, and methods across the vast and fragmented landscape of research literature. As methods of research synthesis spread, researchers adapted it to fit local and field-specific contexts (Grant & Booth, 2009). In the medical and health sciences, research synthesis became entrenched in the evidence-based practice movement, and has since, in association with the randomized control trial (RCT) become central to research systems in these fields (Bastian, Glasziou, & Chalmers, 2010); and to processes undertaken to translate research-based knowledge for practice and policy (e.g., Boaz et al., 2006; Harlen & Deakin Crick, 2004). In other fields, the intensity of use and impact of research synthesis methods varies, though the extent of its use and how it varies at a broad level is unclear due to a lack of systematic and comparative studies across research fields.

Researchers have discussed and studied aspects of the adoption and use of research synthesis in their own fields extensively. Though the quantity of papers is too vast to comprehensively review here, a brief overview of recent writing and research about research synthesis provides an indication of the level and range of interest in this topic. Some advocate for the use of research synthesis methods (Ankem, 2005; Garrett & Thomas, 2006; Madden & Paul, 2011; Rosenberg & Donald, 1995; Saunders, McDowall, & Rojon, 2011; Sutherland, Pullin, Dolman, & Knight, 2004; Urquhart, 2010; Whiston & Li, 2011), critique how research synthesis is implemented (da Silva, Santos, Soares, Franca, & Monteiro, 2010; Gates, 2002; Stewart, 2010; Tirilis, Husson, DeCorby, & Dobbins, 2011), and examine specific elements of the use of research synthesis, such as search and literature retrieval (Glanville, Lefebvre, Miles, & Camosso-Stefinovic, 2006; Krieger, Richter, & Austin, 2008; Whiting et al., 2011; Yoshii, Plaut, McGraw, Anderson, & Wellik, 2009). In work more specifically focused on the impact of the diffusion of research synthesis, Murphy (2003) and DeGeest and Schmidt (2010) examined developments in the field of industrial and organizational psychology following adoption of psychometric validity generalization meta-analysis beginning in the late 1970s; Miller and
Pollock (1994a) analyzed the challenges and potential benefits of meta-analysis as an innovation in social psychology; and Boyle (2012) examined the relationship between research methods and research culture in complementary and alternative medicine (CAM) through the period in which the Office of Alternative Medicine (OAM)\(^1\) and funding for complementary and alternative medicine were initiated at the National Institutes of Health (NIH). A few comparative studies have been performed recently as well. Researchers in criminal justice (Wells, 2009) and social work (Lundahl & Yaffe, 2007) examined trends in the use of meta-analysis in their own fields versus that of others; and Pullin and Knight (2009), in the first paper published in a new systematic review section in Biological Conservation, draw on experiences in the health sciences – and also discuss differences between the health sciences and their own field – as they advocated for a Collaboration for Environmental Evidence. Meanwhile, in the medical and health sciences, systematic reviews of systematic reviews (umbrella reviews or overviews) (Smith, Devane, Begley, & Clarke, 2011) have arrived (Moore & Jull, 2006) – though there continue to be questions about the scalability of the systematic review approach as it is currently implemented (Bastian, et al, 2010), as well as whether different types of reviews and research syntheses are better for different purposes (Card, 2012; Dijkers, 2009; Gurevitch, Curtis, & Jones, 2001).

One aspect of research synthesis that is clear on review of the literature is that use of these methods has diffused unevenly across and within fields of science. Recurrent themes related to the use, non-use, and need for extensions and adaptations of research synthesis methods include the association between research synthesis and the evidence-based practice and policy (EBP) movement; issues related to publication bias (Chavalarias & Ioannidis, 2010; Rosenthal, 1979; Rothstein, Sutton, & Borenstein, 2005) and null hypothesis significance testing (NHST) statistical reforms (Fidler, Geoff, Mark, & Neil, 2004); efforts to synthesize findings of studies from diverse research traditions (Sandelowski, Voils, & Barroso, 2006; Strike & Posner, 1983; Suri & Clarke, 2009); and initiatives related to developing research synthesis methods to fit needs in practice and policy contexts. The relative importance of issues such as these varies by field. As researchers within their fields modify research synthesis to address these challenges, increasingly diverse forms of research synthesis have evolved. In the process, some varieties have lost features extolled in early and primary methods works. Though casual observation of research synthesis publications, methods publications, and evaluative field self-studies indicate that such adaptations have occurred, whether there are trends in these changes – overall, and how these relate to the characteristics of the adapting fields, is unclear.

**Purpose, Objectives, and Research Questions**

The intent of this study is to provide a broad view of the diffusion of research synthesis across science, and compare how implementation of these methods has been adapted within research fields, and finally, to investigate whether and how research synthesis has impacted referencing behaviors as reflected in citation patterns. This study is envisioned in three stages, briefly outlined below.

**Stage I: Diffusion of Research Synthesis**

While researchers have studied the use of research synthesis from the perspective of a number of fields at different times, how these pieces can coherently be placed within the broader context of the science system is unclear. Additionally, while past studies provide information about positive cases, those in which research synthesis is used; negative cases, fields that have not engaged with research synthesis to date, generally have been outside the

---

\(^{1}\) The OAM is now called the National Center for Complementary and Alternative Medicine (NCCAM).
scope of these studies. Therefore, in order to develop a broad overview of the diffusion of research synthesis, contextualize past research, and set the stage for more granular investigations in my own research, I investigate historical and developing trends in use of research synthesis methods across science at the global level in the first of three stages of my research. This first stage is guided by the following research question:

**RQ 1:** When, and to what extent has research synthesis diffused across fields of science?

**Stage II: Adaptation of Research Synthesis Methods**

In order to understand how and to what extent adaptation of research synthesis methods has occurred within science fields, I investigate a select number of fields in more depth. The goal of this stage is to identify patterns of variation in key aspects of how research synthesis is implemented, and to identify, as much as possible, the range of variation in adaptation of research synthesis methods. Therefore, for research at this stage, fields are selected to maximize diversity (Eisenhardt, 1989). Two questions guide Stage II:

**RQ 2.1:** How has research synthesis been adapted at the field level?
**RQ 2.2:** In what ways are trends in adaptation of research synthesis methods similar and different across fields?

**Stage III: Impact of Research Synthesis on Referencing Behaviors**

The intent of the third stage of this project is to assess the impact – or outcomes associated with use of research synthesis methods – conceptualized as shifts in publication use when compared to traditional literature reviews. Whether there is a difference in the outcomes of the use of research synthesis versus traditional research reviews when viewed from the perspective of to what extent and by whom each type of publication is used; and whether and to what extent this varies by field and by length of time research synthesis has been used within a field. (RQ 3.1 - RQ 3.3):

**RQ 3.1:** How do research syntheses and traditional literature reviews differ in terms of the diversity of research audiences who use them and the extent to which they are used by researchers?
**RQ 3.2:** How does RQ 3.1 vary by field?
**RQ 3.3:** If there are differences in how researchers use research synthesis versus traditional literature review publications (RQ 3.2), how do these differences vary based on the length of time research synthesis has been used within a field?

**Significance**

From an information and library science perspective, whether researchers in a given field use research synthesis methods and the characteristics of how research synthesis is implemented is important for a number of reasons, including the emphasis on the transparency of literature selection methods generally advocated in methods guidelines and texts (Sander & Kitcher, 2006). Research syntheses, like traditional literature reviews, often draw on and are intended to integrate large bodies of research literature. Research syntheses differ, however, in that research synthesis methods proscribe how researchers should approach “communing with the literature” (White, 1994, p. 43). These aspects of research synthesis have implications related to the organization and use of information resources and services. The importance of information infrastructures that support centralized access to literature (Bastian, et al., 2010; Eady, Wilczynski, & Haynes, 2008; Lukasik, 2000; Toews, 2011), and to a lesser extent, the potential of the use of bibliometric approaches to literature retrieval (Harris, Beatty, Lecy, Cyr, Sheble)
For the purposes of review and research synthesis has been recognized by researchers in their own fields. These topics have received some direct attention in ILS research (Chen & Chen, 2005; Dang et al., 2009; Hood & Wilson, 2001; Porter, Kongthon, & Lui, 2002; Small, 1986), and are strongly related to broader research interests in specialties that focus on information retrieval, scholarly communications, bibliometrics, and science literature visualization. Additionally, ILS skills and research are highly relevant to the practice and continued development of the methods. ILS practitioners play key roles as consultants to and members of research teams that perform research syntheses (Beverley, Booth, & Bath, 2003; Harris, 2005; Knight & Brice, 2006; McKibbon, 2006; Shell, Hofstetter, Carlock, & Amani, 2006; Swinkels, Briddon, & Hall, 2006), though primarily in the health sciences and medicine. As previously noted, increasing levels of use of research synthesis may also be associated with changes in reference practices and the nature and roles of reviews. The latter is important because reviews have generally been treated as a relatively homogeneous type of publication in science literature studies, though this does not necessarily reflect perspectives across science fields. Finally, in some fields, researchers have suggested that secondary analysis of data collected in the context of multiple studies should be considered a type of research synthesis (e.g., individual participant data (IPD) meta-analysis, Cooper & Patall, 2009; Riley, Lambert, & bo-Zaid, 2010), which suggests links with data archiving and curation research.

From another perspective, research synthesis is potentially interesting to ILS because widespread use of research synthesis may contribute to changes observed in patterns in the citation system (Persson, Glänzel, & Danell, 2004; Wallace, Lariviére, & Gingras, 2009), including trends towards increasing levels of co-authorship (Cronin, 2001; Leahey & Reikowsky, 2008; Morris & Goldstein, 2007; Persson, et al., 2004). For example, in some fields, collaboration is considered beneficial to literature review and synthesis activities because (a) it enables triangulation between researcher evaluations of the relevance and quality of research, (b) the large scale of some research synthesis projects, and (c) needs for multiple types of expertise as it relates to topic-based knowledge and role differentiation associated with instrumental specializations. Collaborative information behaviors in the context of research synthesis was studied by Blake and Pratt (2006)\(^2\), and is important in that this approach to review differs substantially from the traditional notion of reviews as a genre dominated by expert researchers using the sole authorship model to share perspective as well as research-informed expertise (c.f., Cooper, 1986; Peters & van Raan, 1994) to “shape the literature of a field into a story in order to enlist the support of readers to continue that story” (Myers, 1991, p. 45).

Additionally, changes in publication guidelines and standards made in part to accommodate the needs of researchers who perform syntheses (e.g., APA Publications & Communications Board Working Group, 2008) or based on beliefs related to hierarchies of evidence, which often place systematic reviews at or near the top (see, e.g., Merlin, Weston, & Tooher, 2009), suggest that research synthesis may indirectly impact citation patterns (Bhandari et al., 2004; Montori, Wilczynski, Morgan, Haynes, & the Hedges Team, 2003; Patsopoulos, Analatos, & Ioannidis, 2005). Similarly, widespread use of synthesis methods may alter expectations for reviews overall, and therefore contribute to wider changes in practices – though this should not be attributed entirely to feedback mechanisms since the conditions that contributed to the emergence of research synthesis, including the vast and fragmented nature of literature (Swanson, 1986,1990,1993) and beliefs related to the benefits of the cumulative

\(^2\) Blake and Pratt (2006) used the phrase “collaborative information synthesis” (CIS) to refer to collaboration in the context of systematic review.
(e.g., Hedges, 1987) – or at least the connected (Glaser & Strauss, 1971) – nature of research persist.

The study also has the potential to contribute to diffusion research within ILS. There have been a few studies of diffusion processes across science at a broad level (e.g., Kiss, Broom, Craze, & Rafols, 2010), that focus on research methods (Tonta & Darvish, 2010) or topics related to research evaluation (e.g., Zhang, Thijs, & Glänzel, 2011), and that incorporate a comparative approach (e.g., Martens, 2011). This research seeks to focus these approaches on a topic that has had broad implications for research in a number of fields. By examining the impact – or outcomes of the use of research synthesis, conceptualized as shifts in practice when compared to reviews as measured by citations, I corroborate whether, to what extent, and how use of research synthesis methods is important from the perspective of the audience of research authors. Focus on variation and outcomes in a comparative context provides the opportunity to examine how disciplinary cultures and practices moderate use and acceptance of research synthesis, and perhaps enables us to theorize how contextual factors limit and facilitate acceptance of this complex type of innovation.

Outside of ILS, a study of the diffusion of research synthesis methods is also likely to be of interest to researchers and others who have been engaged with its use and development; as well as those involved with the evaluation and publication of reviews. There has been relatively little research related to the diffusion of research methods and practices in general. The current research has the potential to add to this literature and further our knowledge of how methods diffuse, which may be of interest to methodologists more generally, as well as researchers in cognate fields such as the emerging field of the sociology of social research (Leahey, 2008).

**LITERATURE REVIEW**

**Introduction**

The literature reviewed below provides an overview of research synthesis, the diffusion of innovations, the conceptual framework that guides this inquiry, and the functions of research synthesis and traditional literature review in scholarly communications. Literature on research synthesis and diffusions is vast, and therefore I have selected research most relevant to my study. I’ve included a somewhat extended discussion of the historical development of research synthesis – which centers primarily on psychology and medical and health sciences, fields that contributed heavily to the early development of research synthesis – to contextualize the diffusion process and suggest important factors related to the diffusion of this family of methods.

**Research synthesis**

Research synthesis is a document-based empirical research method in which primary research reports are analyzed with the goal of generating new knowledge or interpretations. Research synthesis involves formulating a research problem, retrieving relevant literature, evaluating, analyzing, and synthesizing data, and interpreting the results. The importance of presenting and disseminating findings is often emphasized in research synthesis, and therefore reporting findings is considered the concluding step in the process of a synthesis. Generally, researchers engaging in research synthesis strive to adhere to transparent and systematic procedures (c.f., Noblit & Hare, 1988; Pawson, 2006). As with other research methods, study characteristics vary with the nature of the research questions, the goal of the study, and the epistemological and ontological orientations of the researcher. As a documentary method in
which reports of previous research studies form the basis of evidence, the characteristics of a synthesis will be determined in part by the nature and extent of previous studies; and the availability and documentation of these studies in reports.

The “synthesist” (Cooper & Hedges, 2009) uses recorded research reports as surrogates for direct observation (Alvarez-Dardet & Ruiz, 1993). In a sense, documents serve as a bridge that affords the researcher access to the primary study, mediated by the researcher, documentary genre conventions, and systems that enable access to reports (Platt, 2006). Oxman (1994) likens the process of research synthesis to a survey: “In a review a question must be posed, a target population of information sources identified and accessed, appropriate information obtained from that population in an unbiased fashion, and conclusions derived” (¶13). Oxman’s description highlights the similarity of the process of research synthesis to that of other methods of empirical research. A close examination will also reveal that research synthesis, like other methods, offers the researcher opportunities for creativity, and necessitates potentially difficult decisions.

Research syntheses are conducted for a variety of reasons. For example, research synthesis may be chosen to build or examine theory based on existing evidence; to map out research previously performed in an area in preparation for future research; to support policy or professional practice development; or to resolve questions related to ambiguous or conflicting findings across primary research studies. Studies that use research synthesis may be narrow and focused, or broad and exploratory in nature. A narrow, focused study might be performed to estimate a specific parameter of interest as accurately as possible based on existing evidence. A broader study might be conducted to explore variation in research findings, test competing hypotheses (Chamberlin, 1890; Pawson, 2006), or develop theory (Lajeunesse, 2010; Miller & Pollock, 1994b; Pawson, 2006). Researchers have augmented syntheses with novel primary data collection. For example, in a study designed to compare three models purported to explain the relationship between negative mood and helping behaviors, Carlson and Miller (1987) incorporated assessments made by expert judges to examine the degree to which theoretical variables presented in the models received empirical support in experimental contexts as documented in research reports.

Methods of Research Synthesis: Diversity and Processes

In the case of research synthesis, epistemic and ontic beliefs are revealed by how the method is used, from criteria used to select primary studies, evaluation of these studies, analysis, synthesis (or interpretation), and presentation (or representation) of findings. Research syntheses that can broadly be described as post-positivist appear to be most prevalent in research fields such as medicine and psychology, which are also among the most prolific producers of research syntheses. This tradition generally focuses on synthesizing quantitative evidence from primary research, though some studies incorporate qualitative research either through quantitative analysis of qualitative data, or by using qualitative findings to inform or structure the synthesis. Research synthesis methods developed for an interpretive perspective include Noblit and Hare (1988; Thorne, Jensen, Kearney, Noblit, & Sandelowski, 2004). Realist synthesis can be considered a third category. Realism is sometimes discussed as a “middle road” between post-positivist naturalism and relativism (e.g., interpretivism), perhaps because both quantitative and qualitative data are compatible with a realist perspective – though this is a simplistic view of realism (see, e.g., Elster, 2007; Hedström & Swedberg, 1998).

As these different types of research synthesis suggest, the method is continuing to be
developed such that it may be more accurate to refer to research synthesis as a family of methods that a researcher may adopt in the context of research in which s/he believes analysis of data from reports of prior studies is likely to culminate in new knowledge (e.g., related to causal mechanisms or variables) or understandings of central interest to a question or problem. Across different types of synthetic studies, researchers generally strive for transparency; and develop an inquiry such that it may be described procedurally. Different approaches diverge in how procedural components are implemented, the nature and timing of steps, and other factors such as the degree to which the steps may be iterative. Table 1 presents research synthesis as presented by Cooper and Hedges (1994) and Cooper, Hedges and Valentine (2009) from a post-positivist orientation; and Noblit and Hare (1988) from a meta-ethnographic interpretivist orientation. This presentation is intended to illustrate the processes of two select but diverse approaches to research synthesis in summary form. The degree of similarity between (I) Cooper and Hedges (1994, 2009) and (II) Noblit and Hare (1988) may be traced in part to the influence of Cooper and Hedges on Noblit and Hare (Thorne et al., 2005). However, similarities in processes across research synthesis methods are noted in methodological writings of many researchers (e.g., Gough, 2004).
Table 1. Processes of research synthesis from two perspectives: Cooper and Hedges (1994)/Cooper, Hedges and Valentine (2009); Noblit and Hare (1988).

<table>
<thead>
<tr>
<th>Steps of the research process</th>
<th>I. Cooper and Hedges</th>
<th>II. Noblit and Hare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem Formulation</td>
<td>Identification of a research interest;</td>
</tr>
<tr>
<td></td>
<td>Literature Search</td>
<td>Deciding what is relevant to the initial interest;</td>
</tr>
<tr>
<td></td>
<td>Data Evaluation</td>
<td>Reading the studies;</td>
</tr>
<tr>
<td></td>
<td>Data Analysis</td>
<td>Deciding how the studies are related;</td>
</tr>
<tr>
<td></td>
<td>Interpretation of Results</td>
<td>Translating the studies into one another;</td>
</tr>
<tr>
<td></td>
<td>Public Presentation.</td>
<td>Synthesizing translations;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expressing the synthesis.</td>
</tr>
<tr>
<td>Emphasis on iterative, nature of synthesis?</td>
<td>To an extent. For example, refinement of problem based on findings in the literature search phase advocated.</td>
<td>Identification of relevant literature may be; analysis likely to be highly iterative.</td>
</tr>
<tr>
<td>Criticisms</td>
<td>Narrow range of research designs considered.</td>
<td>Literature selection purposive. If repeated, different results likely.</td>
</tr>
</tbody>
</table>

**Historical overview of research synthesis**

Historical accounts identify the 1960s and 1970s as critical to the development of research synthesis (e.g., Glass, McGaw & Smith, 1981). A turning point was reached when Gene Glass described the statistical analysis of findings from a large number of independent studies in a presidential address to the American Educational Research Association (Kulik & Kulik, 1988) and subsequently published two landmark papers. In the first, Glass (1976) discussed the difference between primary data analysis, secondary data analysis, and “meta-analysis”, a term he coined to describe the use of statistical methods to examine the results of multiple compatible primary studies in combination and synthesize the data. The second paper, by Smith and Glass (1977), used meta-analytic techniques to adjudicate between conflicting opinions expressed in reviews about the relative efficacy of drug treatments alone versus drug treatments with psychotherapy for psychological disorders. In combination, these publications served to heighten awareness of meta-analysis (Kulik & Kulik, 1988). While Glass notes (Glass, McGaw & Smith, 1981) that others, including Rosenthal (1980) and Light and Smith (1971), had been working with similar methods at the time, most prior work might be described as the “pre-history” of research synthesis though this might be due more to a lack of continuity, connection, and widespread awareness of other work rather than large conceptual differences between meta-analytic approaches and prior statistical analyses of primary research reports (see, e.g., Cochran, 1937; Leitch, 1958).

Two important types of early (pre-history) works that are frequently identified in histories of research synthesis include methodological advances – especially from statistics – and early reviews that used systematic approaches to literature review and integration. More recently, Bastian, Glasziou, and Chalmers (2010) provided a broader perspective of the history of “the development of trials and the science of reviewing trials” (p. 2) in medicine, which includes the development of information indexes and systems (e.g., Index Medicus, MEDLINE, trial registries), organizations (e.g., the Office of Technology Assessment (OTA), the Cochrane Collaboration, the Agency for Healthcare Research Quality Evidence-based Practice Centers...
Diffusion of Research Synthesis

Sheble

(AHRQ - EPC), regulations (e.g., the FDA Amendments Act, 2007), and guidelines such as evidence hierarchies, practice guidelines, publication guidelines (e.g., MARS\(^3\), JARS\(^4\)), and reporting standards (e.g., PRISMA\(^5\), MOOSE\(^6\), QUORUM\(^7\)), in addition to landmark studies and publications.

Within science, diffusion of enabling technologies and techniques (Altman, 2000; Altman & Goodman, 1994) and reconciliation of epistemic beliefs with approaches to synthesis (Strike & Posner, 1983) influence the nature of research syntheses, and likely both the extent to which research synthesis methods are used and the importance of synthesis publications across fields. A secondary thread in the history of research synthesis is the impact these methods and the structures that support them do or ought to have on science practice. This is clearest in the context of publication guidelines. For example, one goal of the recent revisions to the American Psychological Association research reporting guidelines was to accommodate secondary analyses of aggregate findings documented in research reports (APA Publications and Communications Board Working Group on Journal Article Reporting Standards, 2008). It has been suggested that wide-spread use of evidence hierarchies that identify meta-analyses and randomized control trials as the “highest” level of evidence (based on internal validity) influence citation patterns directly and through influence on article submission guidelines (Dijkers, 2009). Finally, Clarke, Chalmers, and others have repeatedly called for guidelines necessitating pre- and post-study systematic reviews to assess the contributions of each study (Chalmers & Altman, 1999; Clarke, 2004; Clarke, Alderson & Chalmers, 2002; Clarke & Chalmers, 1998; Clarke, Hopewell, & Chalmers, 2007, 2010).

Research synthesis is framed as having been developed in response to the failings of traditional literature reviews, and in some cases, rather than as an extension of them (c.f., Dickersin & Chalmers, 2010; Dijkers, 2009; Garfield, 1987; Mulrow, 1987). At least three themes recur in discussions of the emergence of systematic approaches to reviewing literature: (1) Pressures associated with increasing numbers of primary research publications (Chalmers, Hedges & Cooper, 2002; Glass, McGaw & Smith, 1981); (2) the roles of reputation and prestige (or “experience and expertise,” Huth, 2009) versus more egalitarian or “fair” evaluations of research findings; and (3) episodic and systemic failures to achieve unbiased estimates of consensus, including for the purpose of communicating “the state of science” to inform policy and practice decisions (Chalmers, Hedges & Cooper, 2002; Glass, McGaw & Smith, 1981; Light & Pillemer, 1984; Light & Smith, 1971; Schulze, 2004).

A number of influential works were published in the 1980s (e.g., Hedges & Olkin, 1985; Rosenthal, 1984; ”Statistics in Medicine,” 1987; Yusuf, Peto, Lewis, Collins, & Sleight, 1985). Jointly, these publications contributed to the stature of quantitative research synthesis among statisticians (Chalmers, Hedges, & Cooper, 2002). Interest in use of research synthesis for policy decisions continued during the 1980s as well. In 1982, the Office of Technology Assessment (OTA) published a report that discussed the potential uses of meta-analysis and systematic

\(^3\) MARS: Meta-analysis Reporting Standards (APA Publications & Communications Board Working Group, 2008).


\(^5\) PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, Liberati, Tetzlaff, & Altman, 2009).

\(^6\) MOOSE: Meta-analyses Of Observational Studies in Epidemiology (Stroup et al., 2000).

\(^7\) QUOROM: QuAlity Of Reporting Of Meta-analysis (Moher et al., 1999), replaced by PRISMA in 2009.
reviews in assessments of health technologies. In 1983, the National Institute of Education published a collection of commissioned essays that explored the potential of secondary research studies to contribute to knowledge in education research, policy, and practice (Ward & Reed, 1983). A notable difference between Ward and Reed (1983) and the 1982 OTA publication is the stronger emphasis on the implications of diverse epistemologies and approaches to research in the context of integrative syntheses of primary studies and also a more integrated discussion of meta-analysis and research synthesis in education. Issues related to divergent research orientations would become important to the diffusion of research synthesis in other fields such as nursing and complementary and alternative medicine (Boyle, in press).

Through the 1970s, 1980s and early 1990s, important developments occurred in the medical and health sciences that culminated in what was to become known as the evidence-based practice (EBP) movement. Archibald (“Archie”) Cochrane is recognized for providing a vision for EBP inseparable from the methods used in medical research, first with his emphasis on RCTs, and second, on systematic review of RCT findings (Alvarez-Dardet & Ruiz, 1993; Chalmers, 2006). Just prior to the establishment of the Cochrane Collaboration, and the declaration of the evidence-based practice (and later, policy) movement (Evidence-Based Medicine Working Group, 1992), publications from two important high-profile lines of research were released, the Effective Care in Pregnancy and Childbirth (ECPC) project (Fox, 2011; Mosteller, 1993) and a study on treatments for myocardial infarction (Antman, Lau, Kupelnick, Mosteller, & Chalmers, 1992). ECPC effectively advocated for and demonstrated the benefit of a systematic approach to review. The ECPC project, which was led by Iain Chalmers at Oxford, resulted in the two volume work, Effective Care in Pregnancy and Childbirth (1989), which contained “syntheses provided by scores of meta-analyses of randomized and quasi-randomized trials...” (Mosteller, 1993 p. 524); a companion guide to practice recommendations, and the Oxford Data Base of Perinatal Trials. In the myocardial infarction study, the authors were able to demonstrate the need for research syntheses through a comparison of textbook advice on treatment for myocardial infarction with results from systematic research syntheses (Chalmers et al., 2002). This research showed that “valid advice on some lifesaving treatments had been delayed for more than a decade, and other forms of care had been promoted long after they had been shown to be harmful” (Chalmers et al., p. 21), with the implication that, for some patients, the cost of not performing clear and valid syntheses was premature death.

EBP catalyzed the diffusion of research synthesis methods. As observed by Lee, Bausell, and Berman (2001), the rapid increase in use of research synthesis in most medical and health sciences is readily apparent from a simple review of search results retrieved by queries for meta-analyses and systematic reviews in databases such as PubMed and the Web of Science. The high visibility and apparent success of EBP fostered the development of evidence-based...
movements in other practice disciplines, including nursing, social work, and librarianship (Trinder & Reynolds, 2000). More than two decades later, it appears that the message of EBP still engenders initiatives in a widening spectrum of fields.

Publications that introduced research synthesis to wider audiences began to appear more frequently beginning in the 1990s. These included Lipsey and Wilson’s (1993) critical assessment of over 300 quantitative syntheses on the efficacy of psychological, educational, and behavioral treatments; and Cooper and Hedges’s (1994) Handbook of Research Syntheses. Meta-Ethnography by Noblit and Hare (1988) is generally recognized as the work that translated the concept of synthetic research methods to an approach congruent with an interpretive perspective.

Despite the apparent success of early studies, research synthesis was not immediately recognized as an important research method on par with primary research. In 2002, Chalmers, Hedges, and Cooper described the acceptance of research synthesis in academia as follows:

Over recent decades, research synthesis has been widely seen within academia as second class, scientifically derivative work, unworthy of mention in reports and documents intended to confirm the scientific credentials of individuals and institutions. Indeed, systematic reviews are sometimes characterized as “parasitic recycling” of the work of those engaged in the real business of science... (pp. 21-22)

More recent studies suggest that this is no longer the case in at least some medical and health science fields (Bastian, Glasziou & Chalmers, 2010; Dijkers, 2009). Acceptance and use of research synthesis in other fields appears to vary greatly, though may be greater in practice-oriented fields due to the association between research synthesis and EBP (Trinder & Reynolds, 2000) and the efforts of influential individuals and highly visible boundary organizations12 (Cash, 2001; Guston, 1999,2001) that have been pivotal to the evidence-based movement. Other factors that may be contributing to the growing number of studies that use research synthesis include the perception that synthetic studies can serve to integrate large and diverse bodies of knowledge; the identification of approaches that can be used to synthesize research across and within groups of studies aligned with different philosophical perspectives; and publications that examine or promote the potential of research synthesis methods within various disciplinary contexts (e.g., Dyba, Kitchenham, & Jorgensen, 2005 in software engineering; Okoli & Schabram, 2010, in information systems; Osenberg, Sarnelle, & Goldberg, 1999, in ecology; Rousseau, Manning, & Denyer, 2008 in management and organization science).

**Functions of reviews and research syntheses**

Generally, research synthesis is regarded as a relatively new form and method for literature review. Noguchi (2006) suggests that review articles serve as bridges between different audiences.13 Though other types of articles may also serve as bridges, this metaphor is

---

12 Such boundary organizations include the Cochrane and Campbell Collaborations and the EPPI-Centre in the UK and health science programs in Australia, Canada, and more recently, the United States (Fox, 2011).

13 The bridge metaphor is conceptually similar to that of boundary objects (Star & Griesemer, 1989), though perhaps more specific with respect to how bridging documents are used: One would expect fewer differences in how a bridging document is used by different audiences compared to how a boundary
especially relevant in the case of reviews and research syntheses, which may be used to integrate previously unconnected lines of research (Leitch, 1958); aggregate and summarize prior findings (Leitch, 1959; Cooper, 1994; Major & Savin-Baden, 2010); translate ideas across disciplinary boundaries (Altman, 1994; Noguchi, 2006), across language barriers (Gordon & Santman, 1981), between generalists and specialists (Cooper, 1986; Noguchi, 2006), across time (Price, 1963), into interdisciplinary contexts (Dijkers, 2009) and for new comers to a field (Luck, 1981). Garfield, who often wrote about reviews and their functions, emphasized the role of reviews in literature discovery: “…every time an author makes a reference he is in effect indexing that work from his point of view. This is especially true of review articles…” (Garfield, 1955, p. 470).

It is important to consider how use of research synthesis may be contributing to changes in how reviews are written and used more broadly. While it has long been recognized that reviews serve many purposes, it is possible that the development of research synthesis, in effect, represents the emergence of the codification of different types of reviews and their associated functions – at least in some fields that have made extensive use of research synthesis. Discussion in research synthesis methods texts (Card, 2012; Cooper, et al., 2009; Petticrew & Roberts, 2006; Sandelowski & Barroso, 2007) and on the roles and uses of traditional literature reviews and research syntheses (e.g., Dijkers, 2009; Hammersley, 2002; Sherman, 2009; Squires, 1989), suggests that this process, though underway in the medical and health sciences, has yet to stabilize. In these fields, this may be especially true in relation to reestablishing the legitimacy of some functions of traditional literature reviews. In other fields, it is less clear whether the distinctions between different types of research synthesis and reviews will be seen as helpful to achieving the goals of research and of research as it relates to practice and policy.

Recent citation analyses in several health and medical science fields seem to support the notion of different functions for different types of research syntheses and reviews. Though past research has shown that review articles tend to be more highly cited than other types of articles (Aksnes, 2003; Ketcham & Crawford, 2007; Moed & van Leeuwen, 1995; Moed, van Leeuwen, & Reedijk, 1996; Peters & van Raan, 1994), studies of health/medical literature indicate that systematic reviews (including meta-analyses) (Bhandari, et al., 2004; Montori, et al., 2003), and meta-analyses (Patsopoulos, et al., 2005) are more highly cited than other types of review. While this may be a reflection of (a) publishing recommendations for authors made available by journals or (b) beliefs about evidence hierarchies, differences do seem to exist.

**Research syntheses relate to the diffusion and integration of research**

Literature reviews research syntheses may serve different functions within science fields. One of the primary intentions of authors who write reviews (Cooper, 1988) and research synthesis (Cooper, et al., 2009) is to integrate ideas and findings of primary research studies. Integration is the process of bringing together a relatively disperse set of ideas and findings. In some ways, this can be viewed as analogous to other practices that bring together diffuse ideas, such as collaboration and interdisciplinary research. This observation is in accord with that of Rafols and Meyer (2010) as it relates to interdisciplinarity and integration; and Liu, Rafols and Rousseau (2012) on the relationship between diffusion and integration. Accordingly, in order to indicate the extent to which diffuse ideas are integrated in a review or synthesis, it seems

---

14 Luck was central to the establishment of the Annual Reviews publishing organization.
appropriate to draw on measures designed to assess interdisciplinarity and outcomes of collaboration.

**Diffusion of Innovations**

Research in the tradition of the diffusion of innovations is focused on how innovations, which may be ideas, technologies, methods, convention, behaviors, or other definable entities, are communicated and spread from person to person across social systems over time. The diffusion paradigm is generally broadly construed, and may consider the spread of innovations across populations, in social networks, or at more granular levels such as across specific boundaries. As might be expected given the broad range of levels of interest, researchers affiliated with a range of disciplines engage in diffusion research. Rogers (2003) traces the emergence of diffusion research to Tarde’s 1903 book, *The Laws of Imitation*, though many recognize the work of Ryan and Gross (1943) on the adoption of hybrid corn among Iowa farmers as the beginning of contemporary diffusion research. Following the work of Ryan and Gross, diffusion research itself was widely adopted in a number of fields, including rural sociology and epidemiology during the 1940s and 1950s. Greenhalgh, Robert, Bate, MacFarlane, and Kyriakidou (2005) credit the rapid diffusion of diffusion research to post-World War II beliefs in technology as a means to solve problems. Reviews of diffusion research by Rogers and Greenhalgh and colleagues (Greenhalgh, Robert, Bate, et al., 2005; Greenhalgh et al., 2005) suggest that diffusion research may have been a case of ‘multiple discovery’ (Merton, 1996), which were brought together under the umbrella of the diffusion of innovations by Katz and Rogers in the 1960s (Rogers, 2003; Ruttan, 1996). Though Chatman, in 1986, wrote that diffusion research was “relatively new to the field of library and information science” (p. 377), by 2006, Case (2007) noted that the “diffusion paradigm” was one of the more prevalent frames in ILS research.

Examples of topics in studies of scientific fields from ILS and cognate fields that draw on the diffusion of innovations include communication practices among scientists (Crane, 1969; Garvey & Griffith, 1971), the development of research fields (Estabrooks et al., 2008; Valente & Rogers, 1995), use of research methods (Tonta & Darvish, 2010), resources (Chen, 2004; Shachak, 2006), and the spread of technologies and ideas in the science system (Chen & Hicks, 2004; Leydesdorff & Rafols, 2011a, 2011b; Tonta & Darvish, 2010). In addition to these studies that explicitly draw on diffusion, it is possible to interpret many studies from ILS and cognate fields that focus on the spread of ideas and change within populations over time within the framework of diffusion. Such studies are especially prevalent in research that focuses on change represented in the scientific literature.

In document-centric work that focuses on the diffusion of ideas across populations, inferences about the relationship between people and ideas may be made based on observations of changes in how ideas are represented in documents. For example, McCain (2011) studied obliteration by incorporation (Garfield, 1975; Merton, 1988) in the context of the Nash Equilibrium. In this study, overall trends in the presence or absence of a reference for the Nash Equilibrium concept varied to over time and by field, though an overall trend towards omitting a reference for the concept was not observed. Hilgartner (1990) examined changes in how a broad estimate of the relationship between diet/nutrition and cancer presented in the highly publicized review *Causes of Cancer* was represented in popular, scientific, and professional media. Across these contexts, there was the tendency to simplify the estimate such

---

that it was represented as more certain and precise than was indicated in the original report. Littell (2008) observed similar patterns in how results of a trial intervention were reported in reviews. Small (1978) discusses the use of highly cited Chemistry articles to symbolize concepts by the group of authors who cite them, a process that may emerge through convergence on meaning after an article is referenced many times (Elkiss et al., 2008) – or may result from other related factors or features of the articles studied.

**Defining diffusion**

Rogers (2003) defines diffusion as “the process in which an innovation is communicated through certain channels over time among members of a social system” (p. 5). The four main elements of interest to classic diffusion researchers are, as indicated in the above definition: (1) the innovation; (2) communication (over certain channels); (3) time (and diffusion decisions and processes); and (4) individuals in a social system. In diffusion studies, researchers typically investigate a subset of these elements. Another way to frame diffusion research is through the specification of dimensions of difference in relation to social, cognitive (or psychological), spatial, temporal, cultural-institutional, and organizational space (Boschma, 2005; see, e.g., Leydesdorff & Rafols, 2011c for an application of this approach in information science). This frame may be especially valuable to studies concerned with the diffusion of innovations across populations. The discussion below draws on a combination of these frames of reference.

**Innovations**

Rogers (2003) identifies six attributes of innovations that lead to more rapid adoption: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, (5) observability, and (6) reinvention potential. According to Rogers (1995, in Rogers, 2003), the first five of these attributes account for 49% to 87% of the variance in the rate of adoption of innovations. Of these, relative advantage, compatibility, reinvention potential, and by extension, complexity are most central to my interests.

**Relative advantage**

Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The ultimate relative advantage of an innovation is the potentially complex set of attributes that relate to the relative costs and benefits of adoption and use of an innovation. Relative advantage may be considered according to the extent to which an innovation is (a) perceived as better than its precursor; and (b) perceived as useful for a given purpose (Moore & Benbasat, 1991). Additionally, an innovation may be considered better because it is perceived to be more economic or efficient or because it is believed to contribute positively to social image or prestige (Adler, Kwon, & Singer, 2003). Low initial investment requirements and immediacy of rewards may further contribute to the likelihood of adoption.

As an innovation, research synthesis has received mixed reviews with respect to its relative advantages over traditional literature reviews. Proponents generally emphasize the relative advantages of the outcomes of research synthesis: findings are believed to be more objective, transparent, and representative of the work of a field related to a stated problem or question (e.g., Mulrow, 1994). Other advantages include that researchers are directed to focus on what researchers actually did – through close engagement with the findings of research – rather than what researchers say they did, as one might if focusing on conclusions or discussions (Cooper & Rosenthal, 1980). Potential advantages include the ability to account for publication bias (Ferguson & Brannick, 2011; Rothstein, et al, 2005), and providing a framework for study inclusion criteria. The latter may be especially important for interdisciplinary reviews (White, 1996). Distinct disadvantages generally accorded to research
synthesis include the time and resources necessary to conduct them. The length of time required to establish confidence in findings through the accumulation of studies and their subsequent analysis can be considered a limitation (Kissin, 2010). Syntheses that include meta-analyses are often perceived as technically complex, and therefore challenging for both readers and researchers.

**Compatibility, complexity, and reinvention potential**

Compatibility, complexity, and reinvention potential comprise three closely related characteristics of innovations. Compatibility is the degree to which an innovation is perceived as being consistent with existing values, norms, beliefs, past experiences, and perceived needs of potential adopters (Rogers, 2003). Complexity, the degree to which an innovation is perceived as difficult to understand and use (Rogers, 2003), may be considered on multiple dimensions, including (a) cohesiveness or divisibility, (b) the heterogeneity and number of users or groups of users involved in adoption; (c) the sophistication or level of intellectual difficulty associated with the innovation; and (d) radicalness, or the extent of change or difference introduced by an innovation (Pelz, 1985). The extent to which the components of an innovation are cohesive, or how easily they are separated may influence how completely an innovation is adopted, or the extent to which it is changed during the implementation process (Pelz, 1985). Denis, Hébert, Langley, Lozeau, and Trottier (2002) argue innovations are complex packages composed of an irreducible hard core of essential elements plus multiple layers of technologies and knowledge. The boundaries of the innovation are fuzzy, and feature a ‘soft periphery’ of supporting structures and systems at the interface between the innovation and its use context. In a given context, the essential elements of the innovation are kept intact, and others translated (Latour & Woolgar, 1986) and edited (Shalin & Wedlin, 2008) to fit the needs of the use context. Carlile (2004) differentiates between transfer, translation, and transformation based on the degree of difference, dependence, and novelty associated with an innovation as it crosses a boundary from one use context to another. These concepts related to how an innovation or idea is changed present a different perspective of reinvention, which Rogers (2003) defines as change or modification by a user in the process of adoption and implementation; or the degree to which an individual’s use of a new idea departs from the core or main version of an innovation (i.e., "fidelity"). The term “adaptation” may also be used in studies that emphasize the heuristic process of negotiating and distributing changes between the use context and the innovation. Ansari, Fiss, and Zajac (2010) suggest technical, cultural, and political factors influence the adaptation of practice in organizational settings.

**Communication**

Communication is the second element of diffusion emphasized by Rogers (2003). Researchers may look at the content, channels, and other attributes of communication that are thought to be of importance in a particular diffusion process. Communication may be considered in terms of mass media versus interpersonal communication, or communications that are external or internal to a social group (for an overview of mathematical diffusion models focused on internal and external communication, see, e.g., Sultan, Farley, & Lehmann, 1990). On another level, the affordances of different modes of communication might be considered (Schramm, 1973). From a strong informational perspective, communication could be interpreted as an individual’s attendance to, acquisition, and interpretation of any of diverse types of information within an environment (e.g., Brookes, 1980; Yu, 2011).

In studies of science, it is common to distinguish between formal and informal communications; and also between communication and collaboration networks. Informal structures can be thought of in terms of interpersonal communication networks. Formal
communications, however, are generally operationalized in terms of citation patterns. It should be noted, however, that references are generally made for a variety of reasons (e.g., Bornmann & Daniel, 2008; White & Wang, 1997), and should therefore be considered rather coarse indications of relationships. Additionally, scientists interested in the same topic may approach the topic from a different perspective, or be associated with different disciplines, and may not cite each other’s work.

Genuis (2005) suggests that a publication can be considered a vehicle for the formation of weak ties between scientists; and others (e.g., Tonta & Darvish, 2010) have considered co-authorship signs of relatively strong ties. While it is common practice to discuss relationships – or ties – between individuals categorically as strong or weak, this dichotomous characterization is a simplification of continua of observed states. In some cases, the strength of a tie is represented using weighted edges in a network, which may provide a more descriptive assessment of the frequency or importance of communication and information exchange. The position of a paper within the network of citations may also be associated with the reception of ideas presented in the paper.

**Diffusion of ideas over multiple dimensions of distance: Diffusion across populations**

Degrees of distance between individuals moderate the accessibility and effectiveness of communication. Broadly, differences along distance dimensions can be collapsed into the concepts of homogeneity and heterogeneity, both of which are integral to a given diffusion process. To an extent, homogeneity ensures effective communication (Rogers, 2003; Weenig, 1993), but heterogeneity or distance is important to the introduction of ideas (Granovetter, 1973, 1983), to overcome deficit thinking (Medin, Bennis, & Chandler, 2010), and is necessary for the development of novel combinations of ideas (e.g., Swanson, 1986; Upham, Rosenkopf, & Ungar, 2010). Ideas of individuals who bridge heterogeneous groups may be especially well received (Burt, 2004). At a more granular level, distance may be defined based on a number of interrelated (Trope & Liberman, 2010) dimensions, including spatial, cultural, organizational, social, cognitive or psychological, and temporal dimensions.

**Spatial distance**

Spatial distances, often discussed in terms of geographical distances, have been found to be an important factor related to the rate and extent of diffusion (Frenken, Hardeman, & Hoekman, 2009). Spatial proximity based on immediate (e.g., Cronin, 2008; Cronin & Shaw, 2007; Hillier & Penn, 1991), local (e.g., Jaffe, Trajtenberg, & Henderson, 1993), national (e.g., Börner, Penunmarthy, Meiss, & Ke, 2006), and international (e.g., Leydesdorff & Rafols, 2011c) scales moderates the diffusion of ideas. In some cases, the effects of spatial distance appear to be diminishing (e.g., with respect to collaboration relationships, Jones, Wuchty, & Uzzi, 2008; Yan & Sugimoto, 2011).

**Cultural distance and institutions**

Cultural distances, defined here as including institutional distances (the inverse of Boschma, 2005, who included cultural distances in institutional distances), relate to political geographies (Lancho Barrantes, Guerrero Bote, Rodriguez, & de Moya Anegón, 2012), language (Liu, 1997), trends in use of research published in different languages (Manten, 1970), political (or power) differences (Bourdieu, 1988; Evans, 2005; Frickel & Gross, 2005; Leahey, 2002); and also behavioral norms that may compel compliance or engender assimilation based on cultural- (e.g., Wouters, 1999) and role-based identification (March, 1999). An example of the latter might include the assumption of different authorial roles, which leads to variations in writing and referencing practices (White & Wang, 1997).
Organizational distance and organizations

It can be useful to conceptualize science fields as loosely coordinated organizing structures; or as consisting of actors with multiple organizational affiliations (Chubin, 1976) such as memberships or affiliations with publishing bodies, professional associations, employing institutions, funding bodies, practice constituencies, and so on. The extent to which these organizational units are formalized varies. It may be helpful to consider organizations as structures that at least to an extent, persist such that they may be recognized as units independent of specific individuals. Using this definition, organizations may or may not be legally defined as such, but are at least recognized by members and non-members as cohesive bodies with defined functions and modes of operation. The notion of organizational distance can be conceptualized as distances between organizational units, which may be indicated categorically or through measures of other distances centered on the organization.

DiMaggio and Powell (1983) argued that diffusion often occurs through mimesis, with organizations adopting new ideas based on observations of prior adoption decisions of others with whom they identify or seek to emulate. This may be referred to as a contagion effect. Processes related to mimicry can be understood as either non-rational bases of decision-making, or decisions based on a different logic of rationalization. Abrahamson (1991) noted that in the business environment, adoption of management innovations does not necessarily reflect the efficacy of the adopted approach. It is possible for innovations that would be effective to fail; and for innovations that are not especially effective to be widely adopted. Abrahamson suggests that these behaviors can be explained based on mimicry (“fads”) and also through limits on available options imposed by third parties (“fashions”). Though contagion effects and rational decisions made based on the “goodness” or suitability of an innovation to a context are often presented as contrasting mechanisms through which adoption occurs, in at least some cases, these may work in concert as innovations diffuse (Strang & Macy, 2001).

Social distance

Social distance is most often operationalized in terms of social structure or networks. Social relationships might be considered in terms of acquaintanceships, friendships, advice networks, and so on. In studies of science, measures may include reports of social proximity and relationships based on co-author and contribution relations (e.g., Cronin, Shaw, & Barre, 2004; Pepe, 2011). Pepe (2011) found that there is a strong overlap between author collaborations and acquaintanceships. Boschma (2005) emphasizes social embeddedness, which underscores the interrelated nature of spatial (Collins, 1974; Duguid, 2005; Leahey, 2006; Polanyi, 1966), cultural (Emirbayer & Goodwin, 1994; Pachucki & Breiger, 2010), and social distance dimensions.

Cognitive Distance

Conceptually, it is possible to distinguish between social relationships and cognitive interest-based affiliations in a social network. Topical focus is a type of intellectual affiliation, or alignment with a research field; and collaboration a working group-based social affiliation. Individuals who are connected via collaboration-based affiliations may or may not have the same intellectual interests. The extent to which they do is likely related to the extent of role differentiation and specialization in a collaborative group. Cognitive similarity is often assessed using measures of conceptual similarity, deduced, for example by co-occurrence of terms or sets of terms in documents (Callon, Courtial, Turner, & Bauin, 1983; He, 1999).

Interrelationship of social distance and referencing behaviors

The relationship between social relationships and referencing behaviors evident via citation analysis is somewhat unclear. White, Wellman, and Nazer (2004) found that
referencing behaviors and social relationships differed in an analysis of an interdisciplinary group of scholars; while a study of referencing patterns associated with three information scientists offers some evidence of an association between social relationships and reference behaviors, strongest at a dichotomous level (having met someone versus not having met someone, (Johnson & Oppenheim, 2007). A study of bibliometricians found subtle positive correlations between social closeness and positive assessments of an author, work quality and publication venue; and negative correlations with low assessments of work quality, contradictory perspective, and use of old methods (Case & Miller, 2011). The extent and direction (i.e., whether positive assessments of work lead authors to seek out social ties, or whether social ties lead to increased rates of citation) of the association between social closeness and referencing behaviors is unclear (Case & Miller, 2011).

Temporal distance

Temporal distance is a primary interest in diffusion studies. Many early diffusion studies were performed with the intention of learning how to increase the speed of adoption of innovations (Rogers, 2003). Time may also be observed in terms of lags in the diffusion process, from awareness of (or exposure to) an innovation to adoption or rejection. Temporal distance also has a unique role in the context of document-based studies. Recorded communications are preserved over time, which extends the life of messages encoded in documents, though interpretations and use (Larivière, Archambault, & Gingras, 2008) of these messages may vary over time, and other factors.

Preservation of access to recorded information over time is, or course a central function of libraries, archives, and other types of repositories (e.g., Furman & Stern, 2011); and in fact, one that may be viewed as rising in importance compared to functions of these organizations in bridging access over spatial distances (Neavill, 1984). In this capacity, information service organizations function as boundary organizations (Cash, 2001; Furman & Stern, 2011; Guston, 1999, 2001). Boundary organizations facilitate disclosure and access (Murray & O'Mahony, 2007) to information across distances, dimensions, and scale (Cash, 2001; Cash et al., 2006), and thereby contribute to the coordination of individual and group interactions with information resources, enabling use, and also contributions to knowledge production (Cash et al., 2006; Furman & Stern, 2011) and accumulation (Murray & O'Mahony, 2007).

Innovation Decisions

Rogers (2003) identifies five stages in the innovation-decision process that an individual may go through from the time s/he becomes aware of an innovation to eventual adoption or rejection: (1) knowledge; (2) persuasion; (3) decision; (4) implementation; and (5) confirmation. Additionally, a sixth step (6) discontinuance may be observed after an innovation has been adopted. The innovation-decision process model may be more appropriate to adoption of simple innovations by individuals and does not neatly transfer to other contexts such as with complex innovations and organizations. Based on cumulative evidence from a number of studies, Greenhalgh, Robert, Bate, et al. (2005) contend that innovation adoption, at least in organizational settings, should not be thought of as a linear process, but as a process of assimilation that consists of 'key observations' (e.g., initiation, development, and implementation or termination) that are not necessarily sequential, coordinated across the organization, or unidirectional. There may be triggers that propel or stall sets of decisions and action sub-processes. In the case of science, intellectual turning points (Chen, 2004; Kuhn, 1970) are triggers that propel research in new directions. Sherman (2009) draws on historical cases (e.g., James Lind’s scurvy research) to suggest that research syntheses may be used to aggregate and preserve accumulated research knowledge for use, such that integrated findings
are available once the social context is amenable to the application of this knowledge. While it is likely that in some cases, social, technological, and other types of change undermine this potential function of syntheses, Sherman's observations suggest research syntheses may support nonlinear innovation.

**Consequences of Innovation Diffusion**

Consequences of innovations are considered to be the changes that occur to an individual or a social system as a result of the adoption or rejection of an innovation (Rogers, 2003; Wejnert, 2002). Consequences may be the result of the complex and often unpredictable interactions between innovations and individuals embedded in a social and cultural context. Consequences can be framed in terms of effects within an innovation-diffusion process, for example, the consequences of additional adoptions of an innovation on other innovation adoption decisions; or in terms of how the adoption of an innovation affects use of other innovations or changes other aspects of interacting systems. Concepts related to the former include information cascades, tipping points, critical mass, the Matthew effect (Merton, 1968). In the context of research synthesis, displacement of use of traditional literature reviews or differentiation of functions and roles based on different genres of review may be a consequence of diffusion.

**Epidemiological Analogies for the Spread of Ideas**

Goffman and Newill’s (1964) application of an epidemic model to the spread of ideas is sometimes categorized as belonging to the larger body of diffusion research (Glänzel, 2003; Greenhalgh, Robert, Bate, et al., 2005) and sometimes as an independent set of ideas (Tabah, 1999). Goffman and Newill (1964) argued that ideas might be likened to infectious agents that are harbored in infected hosts, and therefore amenable to analysis using compartmental epidemiological S-I-R (susceptible – infected – removal) type models (see, e.g., Diekmann & Heesterbeek, 2000). Though Goffman and Newill proposed that their approach might be applicable in diverse circumstances (e.g., the spread of ideas generally, social problems, accidents, etc.), the discussion here is limited to the spread of ideas in science communities, which was the main focus of their paper. In the proposed analogy, infected hosts (authors) harbor ideas (the infectious material), which are transmitted via vectors, such as journal articles. As others in the specified population come into contact with the idea, some would be susceptible, and after a period of latency, might become infectious agents themselves. Others would be resistant to the virulent idea. Goffman and Newill refer to these as “removals”. Of special interest to Goffman and Newill is the spread of the idea over time, and the ability to describe, predict, and promote (via information retrieval systems) epidemics. Epidemics, in this case, were thought to be a positive outcome for ideas. Recent applications of epidemic models to information diffusion include Bettencourt, Kaiser, Kaur, Castillo-Chavez, and Wojick (2008); Gurley and Johnson (2011); and Kiss, et al. (2010). In recent years, epidemiologic models have increased in complexity (Colizza, Barthelemy, Barrat, & Vespignani, 2007). Parameters to estimate the impact of heterogeneity in populations and across subpopulations, as well as to estimate behavioral responses (Funk, Salathe, & Jansen, 2010) are becoming more frequent (c.f., Ferguson, 2007).

**Import and Export of Ideas: An Economic Analogy**

Cronin and Davenport (1989) and Cronin and Pearson (1990) applied the idea of import and export from economics to characterize the extent of independence and dependence of a discipline on – or from – other disciplines. The authors argue that disciplinary robustness is reflected in the ratio of imports to exports, such that disciplines that import more ideas than they export are more dependent, and therefore more vulnerable. Disciplines that export more
than they import, on the other hand, are characterized as more independent and robust. The import-export analogy has been used to describe disciplinary relationships in a number of studies, which have used authors (e.g., Cronin & Davenport, 1989; Cronin & Pearson, 1990) or journal sets (e.g., Cronin & Meho, 2008; Sugimoto, Pratt, & Hauser, 2008) as the basis of data selection and journal titles as the basis of disciplinary classification.

The import-export analogy emphasizes the importance of communication among disciplines, and therefore whether ideas spread across field boundaries. A ratio of intra-disciplinary citations to citation imports would seem to more closely reflect the idea of autonomy, which has been stressed as important to the establishment of disciplines (Bourdieu, 1988; Whitley, 2000). The export of ideas might indirectly be related to autonomy if, for example, the export of ideas contributes to disciplinary prestige and therefore has an impact on the ability of members of a discipline to secure resources. Cronin and Meho (2008) caution that interpretation of import-export ratios is not straightforward, and that the context of a field should be considered. Other interpretations of the importance of the export of ideas have included centrality with respect to a topical area (Grover, Ayyagari, Gokhale, Lim, & Coffey, 2006) and impact or influence of one discipline on another (Sugimoto, et al., 2008).

The import-export analogy could be expanded to develop a greater understanding of the division of labor within science. The notion of complementarity (Bonaccorsi, 2010) between fields suggests that the types of research contributions one field makes to another – for example, whether it exports instrumental, technical, theoretical, or other work, and how the importing and exporting fields benefit from this interaction is potentially an important consideration (Strathman, 1992). This type of influence would not be captured by a between-fields citation analysis alone, but work by Grover et al. (2006) and Strathman (1992) demonstrate that content analysis can contribute to such an understanding.
Bibliography


Leahey, E. (2002). The role of hierarchy in shaping research practice. Doctor of Philosophy, University of North Carolina, Chapel Hill, NC. (UMI Microform 3070870)


Leitch, I. (1958, November 16-21). The place of analytical and critical reviews in any growing biological science and the service they may render to research. Paper presented at the International Conference on Scientific Information, Washington, D.C.


Merlin, T., Weston, A., & Tooher, R. (2009). Extending an evidence hierarchy to include topics other than treatment: Revising the Australian 'levels of evidence'. BMC Medical Research Methodology, 9. doi: 10.1186/1471-2288-9-34


Sage Foundation.


Okoli, C., & Schabram, K. (2010). A guide to conducting a systematic literature review of
Academy of Management Annals, 2(1), 475-515. doi: 10.1080/19416520802211651


