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Toward a Science of Transdisciplinary Action Research

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Abstract This paper offers a conceptual framework for establishing a science of transdisciplinary action research. Lewin's (1951) concept of action research highlights the scientific and societal value of translating psychological research into community problem-solving strategies. Implicit in Lewin's formulation is the importance of achieving effective collaboration among behavioral researchers, community members and policy makers. The present analysis builds on Lewin's analysis by outlining programmatic directions for the scientific study of transdisciplinary research and community action. Three types of collaboration, and the contextual circumstances that facilitate or hinder them, are examined: (1) collaboration among scholars representing different disciplines; (2) collaboration among researchers from multiple fields and community practitioners representing diverse professional and lay perspectives; and (3) collaboration among community organizations across local, state, national, and international levels. In the present analysis, transdisciplinary action research is viewed as a topic of scientific study in its own right to achieve a more complete understanding of prior collaborations and to identify strategies for refining and sustaining future collaborations (and their intended outcomes) among researchers, community members and organizations.

Keywords Interdisciplinary · Transdisciplinary · Collaboration · Action research · Community coalitions · Inter-sectoral partnerships

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Overview

Nearly 60 years ago, Kurt Lewin (1946) exhorted fellow psychologists to embrace his vision of "action research" by working collaboratively with community practitioners to analyze and ameliorate societal problems. During and after World War II, Lewin and his colleagues at the Center for Group Dynamics at MIT undertook several joint projects with government officials and community leaders aimed at translating psychological principles and findings into practical recommendations for resolving social problems such as prejudice and interracial conflict (Lewin, 1948). Lewin's vision of action research profoundly influenced several areas of psychological science and provided the foundation for establishing the Society for the Psychological Study of Social Issues (SPSSI) and the *Journal of Social Issues*.

During the 1950s and 1960s, Lewin's call for the integration of theoretical and applied psychology faded temporarily, as psychologists focused their efforts on developing experimentally sound, laboratory-based strategies for studying human behavior (cf., Dember, 1974; Gergen, 1973; Smith, 1973). One observer of these developments in the field of social psychology was prompted to ask "Whatever happened to action research?" (Sanford, 1970). Nonetheless, widespread interest in action research resurfaced among psychologists during the late 1960s and the 1970s as societal concerns about overpopulation, crowding, environmental pollution, and interracial violence drew increasing attention from behavioral scientists and stimulated new programs of applied research in the areas of environmental, developmental, community, and health psychology (Barker, 1968; Bronfenbrenner, 1979; Craik, 1973; Proshansky, Ittelson, & Rivlin, 1976; Rappaport, 1977; Stokols, 1977).

As increasing numbers of behavioral scientists turned their attention to the study of environmental and social

problems, they found that the implementation of action research principles was more challenging than they had anticipated (cf., Sewell, 1989; Susman & Evered, 1978). In many instances, collaborations between researchers and community members were strained by a mutual lack of understanding of each other's goals and expectations. Often, researchers adopted a "hit and run" model of consultation with community groups, leading to frustration and annoyance among community members. As Sommer (1977) noted, "A psychologist cannot simply walk in off the street, tell other people what they are doing wrong, walk away, and expect them to change their behavior. Rather, one must work with people . . . to facilitate the change process (p. 200)."

Similarly, Sanford (1970) suggested that the behavioral sciences have been too rooted in a "science-engineering model" in which discoveries are first made (e.g., in laboratory settings) and later applied to the analysis of community problems. As Weisman (1983) observed, the science-engineering model does not promote the kind of sustained collaboration among scientists and community groups that leads to effective research utilization in the context of community problem-solving efforts. Altman (1995), Best et al. (2003), and others (e.g., Conner & Tanjasiri, 1999) contend that the effective practice of action research—especially the development of evidence-based, sustainable community interventions—depends heavily on the adoption of community-partnering strategies in which researchers, lay citizens, and community leaders work together, often over extended periods, in a highly collaborative and equitable fashion.

The importance of developing strategies for effective collaboration among behavioral scientists and their community partners was implicit in Lewin's advocacy of action research during the 1940s. Yet, *Lewin's call for action research was issued primarily to psychologists and did not explicitly address the complexities and dynamics of interdisciplinary or interprofessional collaboration.* The past decade has seen a surge of interest and investment in large-scale interdisciplinary research networks and centers, yet too little is known about the circumstances that either facilitate or hinder the processes and outcomes of these endeavors (cf. Kahn, 1993; Morgan et al., 2003; National Academy of Sciences, 2005; National Institutes of Health, 2003; Robert Wood Johnson Foundation, 2002).

For instance, it seems plausible that the determinants of successful collaboration may vary according to the composition and goals of collaborative teams. Specifically, the factors that promote effective collaboration may be different depending on whether: (1) researchers from multiple disciplines are collaborating on the development of interdisciplinary scientific products (e.g., novel theories and research methods); (2) researchers from different fields are working with community members to translate scientific evidence into new interventions aimed at reducing societal problems; or (3)

representatives of community organizations situated at local, state, national, and international levels are integrating their expertise drawn from multiple disciplines and professions as part of a community-wide effort to design and implement broad-gauged policies for improving environmental, social, and public health outcomes (Best et al., 2003; Gray, 1996).

A major premise of this article is that action research initiatives often require coordination among these different types and levels of collaboration (i.e., among scholars working together on scientific projects; among the members of community coalitions collaborating to improve conditions within their local community; and among the representatives of organizations, agencies, and institutions spanning local, regional, and national levels who coordinate their efforts to implement and evaluate major public health policies and programs). These different forms of transdisciplinary collaboration have been studied separately, but they have not been linked together as interrelated processes within a more comprehensive formulation of transdisciplinary action research. For instance, scientific collaborations place greater emphasis on research activities whereas scientist-practitioner coalitions and inter-sectoral partnerships engage more directly in community action. Yet, when they are linked together through the translation of research findings into public policies, these diverse collaborations then comprise interrelated facets and sequential phases of a *transdisciplinary action research cycle*.

By developing an integrative analysis of different forms and levels of TD collaboration, important issues that have been neglected in prior research can be addressed. For instance, from the vantage point of Bronfenbrenner's (1992) ecological systems theory, the efforts of collaborative teams working at microsystem and mesosystem levels within a community may be influenced by macrosystem conditions, such as levels of social capital available at community and regional levels (Perkins, Hughey, & Speer, 2002; Putnam, 2000), and by institutional and public policies that create climates and milieus conducive to effective collaboration (Morgan et al., 2003; TD-Net, 2005) The respective similarities and differences among various forms and levels of collaboration, and the ways in which they influence each other (cf., Speer & Hughey, 1995), are identified as important topics for future study within the proposed conceptualization of TD action research.

This article extends Lewin's conceptualization of action research in at least two respects. First, whereas Lewin's vision of action research focused on the translation of psychological principles and findings into strategies for solving particular community problems (e.g., modification of war-time food preferences in the United States Population), the present analysis more directly examines *processes for cultivating and sustaining collaboration across multiple disciplines* (e.g., the behavioral, social, and biomedical

sciences), lay and professionally oriented community members, and multiple organizations and institutions—all of which are *working to achieve a broad array of shared and highly interrelated community goals* (e.g., reduced levels of poverty, injustice, environmental pollution, physical and mental illness).

Second, the present analysis calls for the establishment of a systematic *science of transdisciplinary action research* as a basis for resolving existing gaps in our understanding of cross-disciplinary collaboration.[1] This newly emerging field approaches transdisciplinary (TD) action research as a topic of scientific study in its own right for purposes of achieving a more complete understanding of prior or ongoing collaborations and identifying strategies for refining and sustaining future collaborations among researchers, community members, and organizations. In keeping with Lewin's (1951) dictum that "there is nothing so practical as a good theory" (p. 169), a major reason for developing a science of TD action research is that by better understanding both the facilitators of and impediments to effective transdisciplinary collaboration, future initiatives can be organized in ways that enable them to more effectively achieve their community problem-solving goals.

Thus, the present analysis builds on Lewin's psychologically-oriented vision of action research by developing a broadly integrative, transdisciplinary model of community research and action that assigns high priority to the study of collaborative interactions and outcomes among scholars, community practitioners, multiple organizations and as they occur within local, regional, national, and international contexts. The conceptualization of TD action research proposed here suggests several questions and directions for future study as outlined below. At the same time, this article is *not* intended to provide a detailed summary of the methods and findings from previous case studies of scientific collaborations and community-based coalitions for health promotion. Detailed reviews of the findings from these previously disparate areas of research are available elsewhere (Butterfoss, Goodman, & Wandersman, 1996; Minkler & Wallerstein, 2003; Stokols, Harvey, Gress, Fuqua & Phillips, 2005; Wandersman, Goodman, & Butterfoss, 1997).

In sum, this paper outlines the core concerns and emerging directions of the science of TD action research. These programmatic concerns and directions include: (1) *definitional and theoretical tasks* such as the classification of diverse forms of cross-disciplinary collaboration, including multi-, inter-, and transdisciplinarity (Rosenfield, 1992), comparisons between place-based vs. geographically dispersed col-

laborations, and analyses of the circumstances that enable different kinds of action research teams to meet their intended goals; (2) *methodological challenges* entailed in developing reliable and valid observational, archival, survey, and interview protocols for measuring the processes and products of transdisciplinary (TD) action research teams working on scientific and community problems at local, state, and national levels; (3) the compilation of "lessons learned" from multiple studies of action research projects and translation of those lessons into *practical guidelines for enhancing future TD collaborations*; and (4) development of new *strategies for training future TD action researchers* that can be implemented in undergraduate, pre-doctoral, post-doctoral, and/or community settings.

The next section examines conceptual issues raised by the scientific study of action research teams and offers a brief summary of what is currently known about TD collaborations based on the findings from prior evaluation studies. These issues are discussed in relation to the scientific and community problem-solving contexts of TD action research. The concluding section of the paper outlines future directions of this new field in the areas of theory development, methodological innovation, derivation of practical guidelines for converting research findings into community action, and designing new programs for training TD action researchers in the coming years.

Conceptual and empirical developments in the science of TD action research

An integrated science of TD action research does not yet exist. Instead, a review of the relevant literature reveals disparate pockets of research (based largely on retrospective case studies rather than prospective field experiments) focusing on qualitatively different kinds or phases of cross-disciplinary collaboration: i.e., those involving primarily *scientific collaborations*, *community problem-solving coalitions*, and *inter-sectoral partnerships* among government agencies, universities, and community organizations (cf. Altman, 1995; Butterfoss, Goodman, & Wandersman, 1993; Gillies, 1998; Gray, 1996, 1999; Kahn, 1993; Stokols et al., 2003; Syme, 2000). Scientists and practitioners may work within particular organizational contexts (e.g., a research center, government agency, non-profit organization) or as members of inter-organizational coalitions and teams (e.g., spanning multiple universities and/or community interest groups). Alternatively, collaborative partners representing multiple sectors of communities, regions, and nations may work together to develop macrosystem policies and programs that encompass broader geographic areas and political jurisdictions. The term *sector* is used here to denote a cluster of organizations, agencies, and institutions operating within a particular political jurisdiction (e.g., municipal, state, provin-

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[1] The term *cross-disciplinary* encompasses at least three different kinds of research collaborations: multidisciplinary, interdisciplinary, and transdisciplinary (Rosenfield, 1992). The definitions of these terms are discussed in the next section of the paper.

Organizational, Geographic, and Analytic Scope of Transdisciplinary Action Research
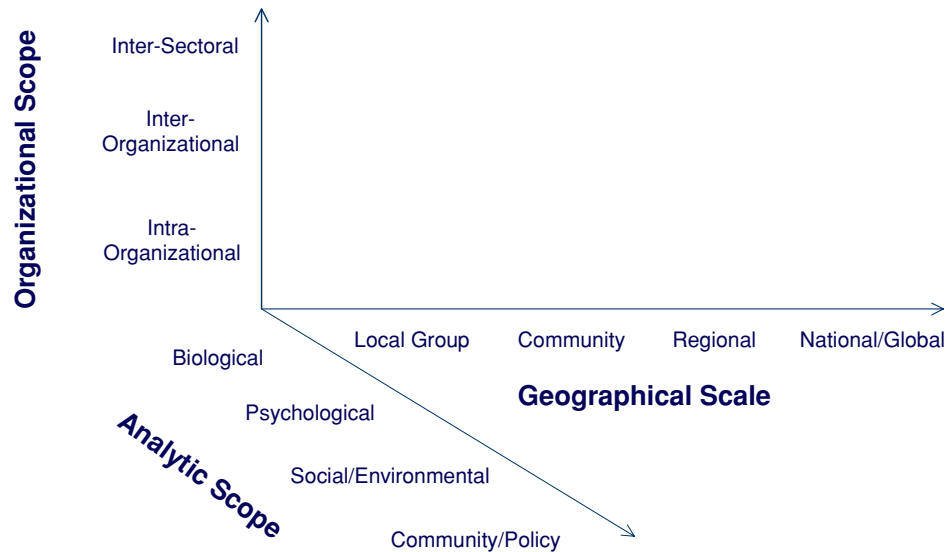

Fig. 1 Organizational, geographic, and analytic scope of transdisciplinary action research

cial, national) that share a common focus on specific societal concerns—for instance, public health, transportation, housing, environmental protection, and community development. _Inter-sectoral_ initiatives entail coordination among two or more distinct sectors.

A key challenge for the future is to integrate the conceptual and empirical knowledge gained by studying these distinct forms of cross-disciplinary and inter-professional collaboration, as each represents a major component or phase of action research—from the achievement of scholarly advances within and across disciplines, to the translation of theoretical and empirical insights into community problem-solving strategies and the consequent elaboration of scientific theories based on the knowledge obtained through community interventions. If the challenge of integrating conceptual and empirical knowledge about these different forms of collaboration is met, we would expect to see several advances in the realm of transdisciplinary action research including: (1) the development of improved strategies for enhancing collaboration among scientists and practitioners; (2) greater sustainability of community interventions and effectiveness of public policies that are grounded in transdisciplinary perspectives and implemented through collaborative efforts among scientists, lay citizens, and government officials; (3) more rapid refinements in existing behavioral and public health theories brought about by the exchange of community-based knowledge among scientists and practitioners (e.g., obtained through systematic evaluations of public policies (cf. Altman, 1995; Campbell, 1969); and (4) the establishment of innovative educational programs for training a new generation of transdisciplinary scholars and practitioners.

Important differences between scientific collaborations, community problem-solving coalitions, and inter-sectoral partnerships—all of which are integral facets of TD action research—pertain to their varying scale or scope. For instance, the _organizational, geographic, and analytic scope_ of transdisciplinary collaboration are depicted in Fig. 1 as three dimensions (ranging from narrow to broad scope) on which scientific collaborations, community coalitions, and inter-sectoral partnerships can be compared. The organizational scope dimension encompasses intra-organizational, inter-organizational, and inter-sectoral contexts of collaboration. The dimension of geographic scale ranges from local groups to community, regional, and national/global levels of collaboration. For both the organizational and geographic dimensions, the narrower levels are nested within each of successively broader levels of collaboration. The third dimension of analytic scope encompasses biological, psychological, social/environmental, and community/policy levels of analysis that can be brought to bear on particular scientific or community problems. As intellectual analyses move from molecular or cellular levels to community and policy perspectives, a wider range of academic and professional vantage points must be bridged to achieve a transdisciplinary approach to the problem/s at hand.[2]

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[2] The dimension of analytical scope, incorporated in Figure 1, suggests that analyses of cross-disciplinary collaborations depend fundamentally on our understanding of what constitutes a distinct scientific _discipline_ (Turner, 2000). Disciplines are organized around the study of particular substantive phenomena—for instance, psychological, social, environmental, and biological "facts" (cf., Durkheim, 1938; Lewin, 1936). The boundaries between specific disciplines and sub-disciplines

An important implication of the dimensions shown in Fig. 1 is that the coordination constraints and challenges facing collaborative partners increase substantially as the scale and scope of their collaborations expand. Thus, scientific collaborations bridging multiple research centers and disciplinary perspectives may be more difficult to sustain than those based within a single organization that attempt to link fewer fields. Similarly, community coalitions bridging multiple stakeholder groups and inter-sectoral partnerships spanning large geographic regions are likely to face more daunting collaborative challenges than local coalitions comprised of fewer organizational partners. Another implication of the model shown in Fig. 1 is that collaborative climates and dynamics occurring at one level or scale may influence (or be influenced by) collaborative activities and experiences occurring at more micro or macro levels (cf., Speer & Hughey, 1995). For instance, recent studies suggest that efforts to empower individuals, organizations, and communities are interrelated in reciprocal fashion (e.g., empowerment of employees within a community service agency may "cascade" or extend beyond the organization, resulting in higher levels of citizen empowerment within the community at large; cf. Feldman & Khademian, 2003).

Additional conceptual and empirical issues related to scientific collaborations, community coalitions, and inter-sectoral partnerships are examined below as part of a more integrative conceptualization of TD action research.

Transdisciplinary scientific collaborations

In recent years, academic interest in transdisciplinary scientific collaboration has grown considerably—reflected, for example, in the establishment of international networks and publications focusing on the study of transdisciplinarity as a research topic in its own right (cf., International Center for Transdisciplinary Research, 2005; Nicolescu, 1996; TD-Net, 2005; Weingart & Stehr, 2000). Within the United States, federal agencies such as the National Institutes of Health, the National Academy of Sciences, the National Science Foundation and private organizations including the MacArthur, Keck, and Robert Wood Johnson Foundations have invested heavily in the establishment of transdisciplinary research centers focusing on a variety of societal problems (e.g., determinants of smoking and substance abuse, obesity and physical activity). Although the research centers funded by these organizations have translational components emphasizing the application of scientific findings in developing new treatment strategies and health promotion programs, a major goal of these centers is to foster intellectual integration and the creation of new knowledge at the interface of multiple fields. This explicit emphasis on promoting integrative research bridging multiple disciplines is closely related to Rosenfield's (1992) distinction between *multidisciplinary, interdisciplinary, and transdisciplinary forms of cross-disciplinary research*.

According to Rosenfield, multidisiciplinarity is a process in which researchers from different fields work independently or sequentially, each from his or her own disciplinary perspective, to address a particular research topic. Interdisciplinarity entails greater sharing of information and closer coordination among researchers from various fields than occurs in multidisciplinary projects, yet the participants remain anchored in their respective disciplinary models and methodologies as do the members of multidisciplinary teams. By contrast, transdisciplinarity is a process by which researchers work together to develop a shared conceptual framework that integrates and extends discipline-based concepts, theories, and methods to address a common research topic. Transdisciplinary research collaborations are intended to achieve the highest levels of intellectual integration across multiple fields and yield shared conceptual formulations that move beyond the disciplinary perspectives represented by team members. Thus, an essential criterion for judging the success of transdisciplinary research centers is the extent to which they promote the development of novel conceptual models and empirical investigations that integrate and extend the concepts, theories, and methods of particular fields (Fuqua, Stokols, Gress, Phillips, & Harvey, 2004; Stokols et al., 2005).[3]

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are to some extent arbitrarily defined and generally agreed upon by communities of scholars (Kuhn, 1970; Thompson Klein, 1990). For instance, the boundaries separating closely related fields such as pharmacology, neuroanatomy, and molecular biology may be non-distinct and even overlapping. Also, some fields such as public health and urban planning are inherently multidisciplinary in that they encompass several different disciplines whose perspectives are combined in analyses of complex topics such as population health and urban development. Despite these definitional complexities, the concept of scientific discipline is useful in that it highlights the *distinctive substantive concerns* (e.g., biological, psychological, social, and geographical phenomena), *analytic levels* (e.g., cellular, cognitive, emotional, interpersonal, organizational, and community), *concepts, measures and methods* associated with particular fields of study. In contrast to *unidisciplinary* research, *transdisciplinary science* involves collaboration among scholars representing two or more disciplines where the collaborative products reflect an *integration of conceptual and/or methodological perspectives drawn from two or more fields*. The intellectual outcomes of unidisciplinary research may share some of the same qualities of TDS outcomes—as measured for example by the quantity, novelty, and utility of new theories and policy recommendations. Nonetheless, it is the *integrative quality and scope* of transdisciplinary research products (e.g., hypotheses, theories) that set them apart from the more traditional intellectual products of unidisciplinary science.

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[3] A distinguishing feature of TD research centers that sets them apart from other large-scale interdisciplinary scientific initiatives (e.g., PO1 and P50 centers, NCI SPORE programs) is their explicit goal of promoting transdisciplinary intellectual integration. Other broad-gauged scientific ventures may include researchers representing diverse

Some scholars contend that the terms, *interdisciplinary* and *transdisciplinary*, are essentially interchangeable and they avoid reference to transdisciplinarity altogether (cf. Maton, Perkins, Saegert, Altman, Guttierez, Kelly, & Rappaport, this issue, for a discussion of this point). The present analysis, however, adopts Rosenfield's (1992) and others' distinction between inter- and transdisciplinarity as it assumes that these two forms of collaboration require qualitatively different "terms of engagement" among collaborative partners. Specifically, transdisciplinarity (more than multi- or interdisciplinarity) requires an *ethic of resolute openness, tolerance, and respect toward perspectives different from one's own* (International Center for Transdisciplinary Research, 2005; Russell, 2005; Stokols, 1998); and a *commitment to mutual learning and mediational processes in which contrasting values and conflicts of interest are negotiated and accepted, if not entirely resolved* (TD-Net, 2005). Transdisciplinary collaborations, thus, are more likely to force participants out of their disciplinary "comfort zones" and require their unwavering commitment to sustained and mutually respectful communications. An advantage of transdisciplinary collaborations is that they often lead to fundamentally new conceptualizations of scientific and societal phenomena and transcend traditional disciplinary boundaries that frame multi- and interdisciplinary analyses (Fuqua et al., 2004; Klein, 1996). Disadvantages of transdisciplinary projects, on the other hand, include their labor intensity and the fact that their potential scientific and community benefits, when achieved, may not be evident for several years or decades (cf., Abrams, Leslie, Mermelstein, Kobus, & Clayton, 2003; Morgan et al., 2003).

Collaborative and non-collaborative forms of transdisciplinary research

Transdisciplinary research centers comprise only one of several different forms of transdisciplinary research. Specifically, these centers emphasize *collaborative* rather than *non-collaborative* or *solo* arrangements for conducting transdisciplinary research. In some instances, individual scientists choose to work on their own in developing an integrative conceptual model that bridges two or more fields without joining a collaborative research team (Stokols et al., 2003). To date, little is known about the relative advantages of these collaborative and non-collaborative forms of transdisciplinary research, although Wilson (1996) contends that solo

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disciplines who achieve conceptually integrative products in the course of working together. However, because TD centers are established with the explicit mission of promoting transdisciplinary science, the evaluative criteria applied to them necessarily include measures of whether novel conceptual and methodological integrations actually are achieved by their participants.

trandisciplinary scholars encounter higher levels of information overload than do the members of collaborative research teams. Non-collaborative researchers, thus, may face greater difficulties in their efforts to assimilate and integrate information across multiple fields than do collaborative teams.

Place-based vs. geographically distributed transdisciplinary research

Transdisciplinary research centers also exemplify place-based collaborations rather than geographically dispersed research teams such as the MacArthur Foundation networks (Kahn, 1993) and several of the Robert Wood Johnson Foundation (2002) Active Living Research Projects. The organizational dynamics and scientific products of geographically centered vs. distributed research teams may be quite different yet few studies have evaluated the relative effectiveness of these alternative collaborative arrangements (cf., Olson & Olson, 2000).

Case studies of transdisciplinary scientific collaboration

A small but growing number of case studies focusing on the processes and outcomes of transdisciplinary scientific collaboration have been conducted since the mid 1990s (Gray, 1999; Higginbotham, Albrecht, & Connor, 2001; Kessel, Rosenfield, & Anderson, 2003; Klein, 1996; Morgan et al., 2003; Rhoten & Parker, 2004; Stokols et al., 2003; Stokols et al., 2005). These studies have assessed various transdisciplinary research centers and networks funded by both public agencies (e.g., NIH, NSF) and private organizations (e.g., the MacArthur and Robert Wood Johnson Foundations). In most of the investigations, survey and interview protocols were administered to team members as they collaborated on diverse scientific topics (e.g., genetic and dispositional bases of nicotine addiction and tobacco use; predictors and processes of successful aging), often over a period of several years. In some cases, behavioral observations of team members' interactions during their research meetings were gathered. Although space constraints preclude a detailed review of the research designs, methods, and findings of each investigation, it is possible to summarize here certain broad themes that have emerged from empirical assessments of transdisciplinary scientific collaboration.

First, earlier studies suggest that transdisciplinary scientific collaborations are *highly labor intensive* and often evoke *tensions and conflicts* among participants (e.g., stemming from their different disciplinary world views, interpersonal styles, departmental affiliations) that must be confronted and resolved if the team as a whole is to achieve its collaborative goals (Gray, 1999; Kahn, 1993; Klein, 1996; TD-Net, 2005). In research teams comprised of biomedical,

behavioral, and social scientists, for example, the contrasting scientific worldviews and values held by these individuals (e.g., reductionism vs. holism, experimental vs. non-experimental study designs) can provoke heated debates and lingering disagreements about conceptual and methodological issues. If these disagreements remain unresolved, they can foster interpersonal tensions, fragmentation of the team into subgroups with non-overlapping (and sometimes competing) agendas, and ultimately undermine the team's ability to meet its collaborative research goals (Higginbotham et al., 2001; Stokols et al., 2005). Moreover, because tensions and conflicts appear to be endemic to large-scale transdisciplinary projects, team members' strong commitment to common goals and the leadership skills of center directors (especially their ability to resolve interpersonal conflicts and promote cooperation) emerge across several studies as essential ingredients for collaborative success (TD-Net, 2005). These team assets enable members to put their disagreements behind them and move forward toward achieving their shared goals (Kahn, 1993; Kessel et al., 2003).

Second, prior evaluations of transdisciplinary science highlight certain contextual factors that strongly influence the *collaborative readiness* of team members and their prospects for success (Fuqua et al., 2004; Gray, 1985; Kessel et al., 2003; Morgan et al., 2003; Olson & Olson, 2000; Stokols et al., 2003). These factors include the presence or absence of institutional supports for inter-departmental and cross-disciplinary collaboration, the breadth of disciplines, departments, and institutions encompassed by a particular center, the degree to which team members have worked together informally on prior projects, the extent to which members' offices and laboratories are spatially proximal or distant from each other, and the availability or absence of electronic linkages (e.g., center-based intranet and Internet sites) among participants. Rather than identifying the relative proportion of variance in team success accounted for by each of the above factors, earlier case studies suggest that the antecedents of collaborative readiness exert a combined or synergistic influence on the processes and outcomes of transdisciplinary science. The more contextual factors that are aligned at the outset to support the goals and activities of transdisciplinary research teams, the greater the prospects for achieving and sustaining effective collaboration across multiple fields.

Third, empirical assessments of research teams and centers indicate that transdisciplinary collaborations *require extensive preparation, practice, and continual refinement*. All too often, scientists enter into transdisciplinary projects with little awareness of the collaborative constraints and tensions they are likely to encounter as they work together over several months or years. Moreover, the intended outcomes or products of transdisciplinary collaboration may not be articulated clearly or mutually endorsed by team members during the

early stages of a project. Unrealistically high expectations for team cooperation and harmony, coupled with ambiguity about shared goals, can result in collaborative set backs and even failures despite the best intentions of all participants at the outset of their project. Thus, the members of transdisciplinary research teams should be prepared in advance for the collaborative challenges they will face and must be willing to devote substantial amounts of time toward cultivating "common ground" at both intellectual and social levels (e.g., by learning to accommodate to each other's different styles) over the course of their projects (Fuqua et al., 2004; Gray, 1999; Kessel et al., 2003; Klein, 1990; Rhoten, 2003).

The findings derived from earlier studies of scientific collaboration have important implications for future research, practice, and training in the science of TD action research. Before discussing those directions for the field as a whole, conceptual and empirical developments related to two other categories of collaboration—partnerships among researchers and practitioners and those involving inter-sectoral cooperation among community groups in the design and enactment of public policies—are reviewed.

Transdisciplinary collaborations among researchers and community practitioners

Collaborations among researchers and community practitioners diverge from purely scientific collaborations in several respects. First, the intended outcomes of researcher-practitioner partnerships are the translation of scientific findings into community-problem solving strategies such as health promotion programs and policies, and the promotion of social justice and community well-being. By contrast, the intended outcomes of scientific collaboration are typically intellectual products such as new conceptual frameworks, methodologies, empirical studies, and peer-reviewed publications reporting on those achievements. Second, collaborations among researchers and community practitioners must bridge not only diverse scientific fields but also a variety of professional and lay perspectives. Third, scientific collaborations tend to be university-centric—that is, the environmental contexts of those collaborations are usually university or research institute offices and laboratories. Collaborative activities among researchers and practitioners, on the other hand, tend to occur within a broader range of community settings including the offices of neighborhood organizations, citizens' homes, as well as the conference rooms or classrooms located at a local university. Thus, the principal goals, educational background, and worldviews (e.g., scientific vs. pragmatic) of team members and the environmental contexts of their collaboration diverge even more dramatically in partnerships involving researchers and practitioners than in those comprised of scientists only.

The differences between scientific collaborations and those involving both researchers and practitioners, at the same time, reflect certain similarities between these two kinds of partnerships. Most importantly, *researcher-practitioner collaborations have the same, if not greater, potential for generating misunderstandings, disagreements, and fragmentation among team members as do those involving researchers only*. For instance, community decision-makers and citizen groups typically give highest priority to the goals of empowering community members, promoting social justice, and enhancing public health (Sutton & Kemp, 2004; Syme, 2000; Syme, Henderson-James, & Ritterman, 2004; Wallerstein, 1992; Zimmerman & Perkins, 1995) whereas academicians are more strongly influenced by the "politics of research" (Altman, 1995) associated with the quest for grant funding and publications. These different motives and incentives for engaging in action research can provoke disagreements and resentments among university- and community-based team members. Moreover, the time orientations of researchers and practitioners often diverge in that scientists tend to favor long-term, detailed analyses of community problems whereas practitioners are more apt to decide on and implement problem-solving strategies relatively quickly even in the absence of "complete" information about the problem at hand (Altman, 1995; Sommer, 1977). And notwithstanding the differences between university and community perspectives, the citizen groups and local agencies participating in an action research team sometimes champion rather different and even competing problem-solving agendas amongst themselves (Gray, 1985; Sutton & Kemp, 2004).

Prior studies of collaborations among researchers and practitioners have identified certain dimensions on which these coalitions differ (Butterfoss et al., 1993, 1996; Gillies, 1998; Wandersman et al., 1997; Wandersman et al., 1996). First, the *continuity of collaboration* among researchers and practitioners throughout the various phases of action research (e.g., from scientific discovery, translation of research findings into practice, empowerment of citizen groups) is an important quality of community problem-solving teams that influences their effectiveness and sustainability. To the extent that researchers and community members work together throughout all phases of the action research cycle (i.e., from defining key research questions to developing, implementing, and evaluating strategies for improving community health outcomes), their prospects for collaborative success are much greater than in cases where the contacts between researchers and practitioners are intermittent rather than sustained over an extended period (Altman, 1995; Syme, 2000).

Second, the *salience of status differences between scientific "experts" and practitioner non-experts* participating in action research teams can vary widely. To the extent that

potential differences in status and power between university- and community-based members of collaborative teams are deemphasized, the prospects for achieving effective and sustainable solutions to community problems are greater (Easterling, Gallagher, Drisko, & Johnson, 1998; Minkler, 1997; Minkler & Wallerstein, 2003; Schensul et al., this issue). Other dimensions on which community problem-solving coalitions may vary include the *clarity and complexity of their goals and intended outcomes* and the *diversity of competing interests represented in the coalition*. In general, collaborations whose goals are ambiguous and whose members span a wide array of potentially competing interests face greater collaborative challenges than those whose goals are clearly defined, perceived to be attainable, and whose participants are relatively united across a variety of community interests and agendas (Florin & Wandersman, 1990; Gray, 1985; Schermerhorn, 1975).

Previous studies of community-based coalitions, like those focusing on transdisciplinary scientific teams, suggest that participants' readiness for collaboration varies in relation to situational factors such as those noted above—i.e., the continuity of researchers' and practitioners' collaboration, the salience of status differences among them, the clarity and complexity of anticipated goals and outcomes, and the diversity of competing interests represented within the coalition. Moreover, assessments of community coalitions as well as those of scientific teams reveal that transdisciplinary collaboration is commonly associated with conflicts and tensions and that both kinds of partnerships require extensive communication and practice to ensure their success. For instance, Sutton and Kemp's (2004) study of a university-community collaboration undertaken to positively transform a low-income neighborhood in Seattle indicated that initial conflicts among team members offered opportunities for them to engage in constructive discussions and enhance their levels of "cultural competence" and mutual understanding. Sutton and Kemp's study underscores "...the need for articulating explicit social justice values prior to embarking on interdisciplinary reflexive discourse, both internally with faculty and students, and externally with community constituents (p. 27)." Their findings suggest that higher levels of communication about collective goals and potential conflicts at the outset of a collaborative project can improve the team's prospects for subsequent success.

The scale and complexity of transdisciplinary collaborations among researchers and practitioners increases further as a larger number of government agencies and community groups join forces to implement evidence-based programs and policies aimed at improving public health (Bracht, 1990; Green, 2001; Syme, 2000). The next section examines these inter-sectoral partnerships among government agencies, universities, and community organizations.

Inter-sectoral partnerships for designing and implementing public policies

Inter-sectoral partnerships undertaken to promote improved public health outcomes are an essential component of action research—especially during the policy design, implementation, and evaluative phases of community improvement projects. The public policy goals of inter-sectoral collaborations are often anchored in transdisciplinary conceptualizations of particular societal problems—for instance, ecological analyses of the "obesity crisis" in the United States that integrate economic, social, political, psychological, and urban design perspectives on the problem (King, Stokols, Talen, Brassington, & Killingsworth, 2002; Rashad & Grossman, 2004). An excellent example of a transdisciplinary conceptualization for developing health policies and programs spanning multiple community sectors (e.g., education, agriculture, religion) is Breslow's (1996) social ecological framework for promoting healthy lifestyles. Moreover, transdisciplinary collaboration not only informs the design and implementation of broad-gauged public policies but also facilitates efforts to evaluate their outcomes at multiple levels of analysis (ranging from assessments of individual health outcomes to epidemiologic studies of policy impacts within a specified population) as exemplified by Breslow and Johnson's (1993) study of the public health impacts of California's cigarette tax (Proposition 99).

Owing to their complexity and broad scope, inter-sectoral partnerships pose a unique set of collaborative challenges. For instance, these partnerships encompass larger geographic regions (e.g., municipalities, provinces, nations) and a broader array of organizational, institutional, and governmental agendas than either scientific collaborations or university-community coalitions–both of which are typically narrower in scope (cf., Ashton, Grey, & Barnard, 1986; Best et al., 2003). Moreover, opportunities for face-to-face communication among representatives of multiple community sectors are fewer than those available to members of transdisciplinary research teams and community coalitions tied to particular localities (e.g., neighborhood improvement projects). Thus, the members of inter-sectoral partnerships must rely more heavily on written, telephone, and electronic communications to coordinate their joint efforts. Electronic communications across large distances present greater collaborative challenges than face-to-face meetings and require that team members be prepared for and trained in the use of new information technologies if they are to establish and maintain an effective partnership (Olson & Olson, 2000).

Modeling the processes and outcomes of inter-sectoral partnerships for community change is particularly difficult owing to their complexity and extended timeframes. Nonetheless, the findings from prior case studies converge on certain factors that facilitate or impede the effectiveness of these collaborations. First, it is essential that efforts be made to regularly involve representatives of all participating organizations and agencies in collaborative discussions to articulate and endorse the major goals and intended outcomes of the partnership (Gillies, 1998). A lack of consensus about collective goals, non-participation of key stakeholder groups, and competition among constituents for limited resources are circumstances that have been found to undermine the success of inter-sectoral partnerships (Altman, 1995; Gray, 1985).

Second, because the translation of scientific findings into evidence-based public policies and subsequent evaluation of those policies extend over multiple years and even decades, it is crucial that political and financial support of the partnership's activities be secured not only at the outset but also over the course of the entire project (Syme, 2000). The implementation and evaluation of California's "Proposition 99" tax on cigarette sales, and the use of tax revenues to support statewide tobacco research and smoking prevention programs exemplify a community-change effort that could only have been sustained through longstanding political and financial support (Breslow & Johnson, 1993; Siegel, 2002). In the absence of substantial resources to sustain collaboration, inter-sectoral partnerships spanning diverse organizations and institutions will inevitably falter and become non-viable within a relatively short period.

Third, the long-term success of inter-sectoral partnerships is enhanced by the presence of highly skilled leaders and enthusiastic program champions who are uniquely able to promote cooperation among team members and engage the support of others (Goodman & Steckler, 1989; Stokols, 1992; Wandersman et al., 1996). The success of large-scale partnerships spanning multiple agencies, organizations, and institutions may actually depend on the availability of multiple program champions situated within each of the participating sectors whose joint efforts keep collective goals salient and facilitate coordination among constituent organizations and team members (Altman, 1995).

As a recap of the preceding discussion, Table 1 offers an overview of the varying goals and attributes of transdisciplinary scientific collaborations, community coalitions among scientists and practitioners, and inter-sectoral partnerships for policy design and implementation, and also highlights "lessons learned" from prior research about circumstances that either constrain or facilitate effective collaboration in scientific, community, and inter-sectoral contexts.

Developing a unified science of TD action research

The above sections summarized earlier studies of the processes and outcomes associated with three facets of TD action research: i.e., scientific collaborations, community coalitions among researchers and practitioners, and large

Table 1 Factors that constrain or facilitate transdisciplinary collaboration in scientific teams, community coalitions, and inter-sectoral partnerships: Lessons learned from prior research

Collaboration types key attributes	Transdisciplinary scientific teams and centers	Community coalitions among scientists and practitioners	Inter-sectoral partnerships for policy design and implementation
Major Goals	Production of innovative intellectual products such as new theories, empirical findings, and training programs	Translation of scientific findings into community-based interventions that promote public health and social justice	Design and implementation of broad-gauged health policies spanning local, state, national, and international levels
Factors that constrain collaboration	Conflicts among alternative disciplinary views of science	Conflicts arising from clashes between scientific and pragmatic world views	Encompass a broader array of scientific, organizational, and institutional agendas than purely scientific teams or community coalitions, and thus face greater coordination constraints
	Substantial time required to establish common conceptual ground and informal social ties	Perceived status differences among academic and non-academic participants	Opportunities for face-to-face interaction are fewer among the representatives of multiple sectors than among participants based in single organizations or community sectors
	Bureaucratic impediments to cross-departmental collaboration	Substantial time and resources required to coordinate participants' activities across academic and non-academic settings	Heavily dependent on electronic vs. face-to-face communications due to geographic dispersion of constituent groups
	Unrealistic expectations and ambiguity about shared goals and products	Tensions arising from competing agendas of participating community-based organizations	
Circumstances that facilitate collaboration	Members' strong commitment to achieving transdisciplinary goals and outcomes	Maintain continuity of participation among coalition members from inception to completion of the project	Secure political and financial support over all phases of the project to maintain continuity and momentum of the partnership's public policy initiatives
	Interpersonal skills of team leaders	De-emphasize status differences among scientific "experts" and community practitioners	Schedule regular face-to-face meetings among representatives of all participating organizations to articulate and endorse the partnership's policy goals and intended outcomes
	History of prior collaboration among team members	Promote clarity of shared goals and intended outcomes of the coalition's efforts	Minimize competition for scarce financial resources among constituent agencies and organizations over the course of the project
	Spatial proximity of team members' offices and laboratories	Maintain regular communication among constituent groups and their representatives to promote "cultural competence" and mutual understanding	Recruit and retain highly skilled leaders and "program champions" to articulate and promote the partnership's health and social policy agendas
	Schedule frequent face-to-face meetings for brain-storming of ideas	Make efforts to ensure that all relevant community stakeholder groups are represented within the coalition	
	Establish electronic linkages among participants		
	Foster institutional supports for transdisciplinary collaboration		

scale inter-sectoral partnerships spanning multiple organizations, institutions, and agencies. The findings from prior studies reveal certain unique features of these collaborations—especially, *their diverse goals* and *varying levels of complexity and scope*—while also highlighting important commonalities among them—for instance, the *conflict-prone nature of transdisciplinary and inter-organizational collaboration* and the *importance of pre-collaboration training and preparation* as strategies for increasing the likelihood of longer term success. Moreover, certain factors such as *spatial proximity* among team members, *a shared history of collaboration on prior projects*, *clear and equitable communications about collective goals and outcomes*, and the *presence of leaders who are able to foster a climate of cooperation*, all enhance participants' readiness for collaboration and prospects for success, whether they are university scientists working across diverse disciplines or the representatives of multiple community sectors coordinating their efforts on a public policy initiative.

Although much has been learned about transdisciplinary scientific collaborations, researcher-practitioner coalitions, and inter-sectoral partnerships, the knowledge base pertinent to these different facets of TD action research remains sketchy and disjointed. A unified science of TD action research, ideally, should provide a more integrated conceptualization of how the processes of scientific discovery, translation of research findings into community practice, and the coordination and refinement of evidence-based policies and programs fit together. Important directions for future research are to (1) establish a comprehensive taxonomy of situational factors that influence participants' readiness for collaboration and (2) a theoretical account of which variables (among several potentially relevant ones) are likely to have the greatest impact on the effectiveness of scientific teams, researcher-practitioner coalitions, and inter-sectoral partnerships.

The development of a more integrated science of TD action research also poses several methodological challenges. One set of challenges relates to the fact that *there has been little agreement across prior studies about how to measure transdisciplinary collaborative success* (cf., Gillies, 1998; Gray, 1996). The lack of agreement about the most appropriate criteria for gauging success stems partly from the unique features (e.g., substantive focus, size, organizational complexity, intended outcomes) associated with different kinds of collaboration. The success of a transdisciplinary scientific team, for example, might be gauged by obtaining peer evaluations of the novelty and scientific impact of the theoretical ideas or research findings produced by team members. The effectiveness of a community coalition or inter-sectoral partnership, on the other hand, would more likely be measured in terms of the public health improvements achieved through those collaborations.

In addition to evaluating the *outcomes or tangible products* of transdisciplinary collaboration, it is important to assess various *interpersonal and inter-organizational processes* that either facilitate or hinder a group's efforts to produce certain "deliverables." Whereas frequent brainstorming sessions and scientific retreats have been shown to be effective in facilitating collaboration and productivity at transdisciplinary research centers (Fuqua et al., 2004; Stokols et al., 2003) citizen empowerment, consensus-building, and technical assistance processes appear to be more closely related to the success and sustainability of community-based coalitions (Altman, 1995; Wandersman et al., 1996). Thus, both formative (process-oriented) and summative (outcomes-based) criteria (Scriven, 1991) of collaborative success should be incorporated into future evaluations of transdisciplinary partnerships and teams.

Future efforts to evaluate the success of collaborative teams also must distinguish between *process and outcome measures related to the effective implementation of transdisciplinarity*, per se—e.g., whether or not a group of scientists from multiple fields is able to produce transdisciplinary conceptual frameworks that integrate and move beyond their respective disciplines (Rosenfield, 1992)—and *those tied more directly to the substantive or community-change goals of a particular collaboration*—e.g., advancing the field of tobacco science or promoting the positive transformation of a low-income neighborhood (cf., Abrams, 1999; Sutton & Kemp, May, 2004). A unified science of TD action research must address the challenges associated with developing both kinds of evaluative criteria (i.e., transdisciplinarity-focused as well as substantive or "mission-oriented" measures) for gauging the success of scientific and community collaborations.

A second set of methodological challenges relates to the *almost exclusive reliance on retrospective case studies rather than prospective experimental or quasi-experimental designs* in prior research on transdisciplinary collaborations (cf., Campbell, 1969; Stokols et al., 2005). Because any collaboration is a unique historical event embedded in a complex array of contextual circumstances, it becomes difficult to experimentally vary certain key elements of a collaboration (e.g., spatial proximity or separation among team members and/or their experiences in working together on prior projects) and draw causal links between those variations, on the one hand, and the quality of team processes and outcomes, on the other. The methodological constraints of conducting randomized or quasi-experimental assessments of collaborative processes and outcomes are quite challenging within each realm of transdisciplinary collaboration outlined above (i.e., scientific teams, community coalitions, and inter-sectoral

partnerships).[4] Moreover, the prospects for establishing causal links between antecedent conditions, collaborative processes and products becomes even more daunting as the scale, complexity, and scope of intended outcomes increase—e.g., as the evaluative focus shifts from a small transdisciplinary research team to a more broadly-gauged multi-sectoral partnership (cf., Jackson, Altman, Howard-Pitney, & Farquhar, Fall, 1989; Lipsey, 1988).

Future collaborative initiatives may offer opportunities for prospectively comparing and, perhaps intentionally varying, the organizational strategies adopted by multiple scientific or community problem-solving teams that are established at the same time, and whose mission (e.g., reduction of teen smoking or obesity at community levels) and anticipated duration are the same. Opportunities to conduct prospective comparisons of multiple transdisciplinary teams, all of which were established at the same time with identical or highly similar missions, may be presented by current and future investments in large-scale TD action research initiatives among federal agencies and private foundations (cf. National Academy of Sciences, 2003; National Institutes of Health, 2003; Robert Wood Johnson Foundation, 2002). However, because opportunities to conduct randomized or quasi experimental studies of transdisciplinary collaborations are quite limited, a more realistic goal in many instances may be the development of *prospective case studies* that are anchored in one or more grounded theories (Glaser & Strauss, 1967; Lincoln & Guba, 1986) of scientific, community-based, or inter-sectoral partnerships; and that are designed to gather data pertinent to

specific questions or hypotheses posed by those theories. An example of this approach is Fuqua's (2002) and Stokols et al.'s (2003) prospective comparative study of multiple TTURC centers along different dimensions of collaboration readiness, which were identified in an earlier phase of this grounded theory-based research.

In addition to the conceptual and methodological issues outlined above, the science of TD action research suggests new directions for *translating research findings about the dynamics of transdisciplinary teams into practical guidelines for enhancing the success of future collaborations*. For example, when developing and reviewing proposals to establish transdisciplinary research centers and partnerships, preliminary *audits of collaboration readiness* could be performed by funding organizations and prospective team members to identify possible constraints on teamwork and coordination (Stokols et al., 2005). These audits might incorporate a checklist of potential impediments to collaboration (e.g., ambiguity of intended outcomes, geographic separation among participants, lack of convenient access to electronic communications technologies, and the absence of formal or informal agreements about data sharing and inter-organizational cooperation) that have been identified through prior studies of transdisciplinary scientific and community-change initiatives (cf., Altman, 1995; Morgan et al., 2003). Prospective participants would be required to address these issues as part of the proposal development process and funding decisions could be made contingent on their efforts to resolve, at the outset, any circumstances that might undermine collaborative success.

Moreover, as new initiatives to support transdisciplinary collaborations are begun, concerted efforts should be made to assess their effectiveness and sustainability. The cumulative findings from these assessments would contribute to the scientific database on TD action research. Along these lines, *funding organizations should allocate budgetary support for systematic evaluations of transdisciplinary teams and centers when new grants for establishing collaborative projects are awarded*. If conducted over extended periods, future evaluations of transdisciplinary collaborations might enable researchers to assess the temporal links between near-term products of those initiatives (e.g., the development of shared conceptual models or organizational strategies to facilitate technical assistance and feedback among researchers and practitioners) and longer-term outcomes at scientific, community, and societal levels (e.g., major paradigm shifts in science or improved health outcomes among community members).

Finally, a unified science of TD action research would inform the development of educational strategies for training a new generation of transdisciplinary scientists and community practitioners. Within university settings, courses and research mentorship opportunities emphasizing

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[4] The challenges of evaluating community-based coalitions for health promotion are discussed by Wandersman et al. (1996), Israel, Schulz, Parker, and Becker (1998), Butterfoss et al. (1996), Fawcett et al. (2003), and Minkler and Wallerstein (2003). Key constraints include small sample sizes and difficulties in identifying comparison groups and the most appropriate outcome measures (e.g., of improved public health outcomes relative to comparison communities; assessments of a coalition's effectiveness in accomplishing its intended goals). Within the realm of transdisciplinary scientific collaboration, prospective evaluations of collaborative effectiveness are difficult to achieve due to the non-random selection of scientists into collaborative research teams. Moreover, the evaluators of scientific ventures tend to be non-neutral parties in that they are either participants in these collaborations who have a vested interest in their renewal and continued support; or they are non-participants who may bring a decidedly critical stance toward the evaluation since they remain outside of the initiative and, therefore, do not benefit directly from its continuation. Further, few methodological tools or "yardsticks" for evaluating the scientific, policy and health outcomes of collaborative research—let alone, for discriminating between transdisciplinary and non-transdisciplinary outcomes of those ventures—presently exist. Finally, the appropriate timeframe for assessing the scientific "returns on investment" or the "value-added" attributable to large-scale scientific collaborations has not been established. Identification of the scientific and public health benefits accruing from substantial investments in transdisciplinary scientific collaboration may require a broad historical timeframe spanning multiple years of even decades. See Rhoten (2003) and Stokols et al. (2003) for further discussion of these issues.

transdisciplinary approaches to science and community action should be developed. These curricular components of undergraduate, graduate, and post-doctoral training programs strongly influence the development of a transdisciplinary orientation among students (cf., Lattuca, 2001; Mitrany & Stokols, 2005; Nash et al., 2003). And within community contexts, new workshops and training modules focusing on the challenges associated with transdisciplinary collaborations and practical strategies that can be used by participants to improve their communications and coordination efforts would provide a valuable resource for the members of scientific teams, community coalitions, and inter-sectoral partnerships.

The preceding discussion provides only a brief sketch of earlier research on transdisciplinary collaboration and programmatic directions for establishing a more integrated science of TD action research. Nonetheless, this summary of prior studies and programmatic directions highlights the many exciting opportunities presented by this newly emerging field for achieving scientific advances and societal improvements.

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