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Community, Culture and Sustainability in Multilevel Dynamic Systems Intervention Science

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Abstract This paper addresses intertwined issues in the conceptualization, implementation and evaluation of multilevel dynamic systems intervention science (MDSIS). Interventions are systematically planned, conducted and evaluated social science-based cultural products intercepting the lives of people and institutions in the context of multiple additional events and processes (which also may be referred to as interventions) that may speed, slow or reduce change towards a desired outcome. Multilevel interventions address change efforts at multiple social levels in the hope that effects at each level will forge synergistic links, facilitating movement toward desired change. This paper utilizes an ecological framework that identifies macro (policy and regulatory institutions), meso (organizations and agencies with resources, and power) and micro (individuals, families and friends living in communities) interacting directly and indirectly. An MDSIS approach hypothesizes that change toward a goal will occur faster and more effectively when synchronized and supported across levels in a social system. MDSIS approaches by definition involve "whole" communities and cannot be implemented without the establishments of working community partnerships This paper takes a dynamic systems approach to science as conducted in communities, and discusses four concepts that are central to MDSIS—science, community, culture, and sustainability. These concepts are important in community based participatory research and to the targeting, refinement, and adaptation of enduring interventions. Consistency in their meaning and use can promote forward movement in the field of MDSIS, and in community-based prevention science.

Keywords Culture · Community · Sustainability · Multilevel · Intervention · Dynamic · Systems · Science

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> Unless we have an image of change as an ongoing process, a stream of interactions,and a flow of situated initiatives, as opposed to a set of episodic events, it will be difficult to overcome the implementation problems of change programs reported in the literature (Tsoukas and Chia 2002).

> More precisely, local action/research interventions need to be conceptualized and approached as but one element in a larger network of action in order to ensure sustainability. A vital aspect of our perspective is that local interventions depend heavily on the support of similar action research efforts in other locations (Braa et al. 2004)

> In the longer-term, of course, pursuing sustainability leads to failed projects, disillusionment among donors, and the search for the next development panacea. Rather than pursue the illusion of sustainability, development organizations and developing country governments would be better off rigorously evaluating their projects, ultimately identifying a limited number with high social returns, and funding these interventions on an ongoing basis (Kremer and Miguel 2007).

This paper addresses intertwined issues in the conceptualization, implementation and evaluation of multilevel dynamic systems intervention science (MDSIS). We

conceive of Interventions as efforts to introduced planned change into social systems. Consistent with Hawe's work, we think of interventions as systematically planned, conducted and evaluated social science-based cultural products intercepting the lives of people and institutions in the context of multiple additional events and processes (which also may be referred to as interventions) that may speed, slow or reduce change towards a desired outcome (Hawe et al. 1997; Hawe et al. 2009). Multilevel interventions address change efforts at multiple social levels in the hope that effects at each level will forge synergistic links facilitating movement toward desired change. Like Trickett and colleagues, (Trickett 1997; Trickett 2009; Trickett and Ryerson Espino 2004), we find it useful to use an ecological framework that identifies macro (policy and regulatory institutions), meso (organizations and agencies with resources, and power) and micro (individuals, families and friends living in communities) interacting directly and indirectly (Bronfenbrenner 1979, 1989; Bronfenbrenner and Crouter 1983). An MDSIS approach hypothesizes that change toward a goal will occur faster and more effectively when synchronized and supported across levels in a social system. MDSIS approaches by definition involve "whole" communities and cannot be implemented without the establishments of working community partnerships (Arnold and Fernandez-Gimenez 2007; DiClemente et al. 2007; Israel et al. 1998; Israel et al. 2001; Peterson and Randall 2006; Rylko-Bauer et al. 2006).

In this paper we will discuss four concepts that are central to MDSIS—science, community, culture, and sustainability. These concepts are important to unpack because they are widely believed to be central to community based participatory research and to the targeting, refinement, and adaptation of enduring interventions. In the interdisciplinary social sciences, there is considerable debate about their meaning, operationalization and evaluation. Resolving inconsistencies in their definition and use can promote forward movement in the field of MDSIS, and in community-based prevention science, a subset of MDSIS, which we address in this special issue.

Community based prevention science, a field that emerged in the 1980s, recognizes multiple social science theories of prevention that are tested in interventions designed to *prevent* identifiable health, mental health and social problems before they occur or accelerate. Early approaches focused on individual level prevention. Over time, however, influenced by social ecology (Hawkins et al. 1992; Trickett 1997), the emphasis in the field has shifted to introducing preventive interventions into social institutions (families, peer networks and schools), and more recently, at the "community" level (DiClemente et al. 2007; Hyland and Bennett 2005; Israel et al. 2001; Linnan and Ferguson 2007; Monkman et al. 2007; Pattussi et al. 2006; Trickett and Pequegnat 2005; Williams et al. 2000).

Prevention science at the community level has raised many challenges with respect to the definition of community, where, how and at what level prevention approaches should be introduced, how to measure them using quasi-experimental or case study designs, and how to approach issues of sustainability. These questions apply to all forms of intervention, but are especially problematic with respect to prevention which is a less tangible, more challenging concept to identify, and measure over time. To address them, we begin with a brief interpretation of the history of science and its evolution into a new framework consistent with contemporary understandings of "community", culture and sustainability.

Science and System

> "The world is no longer a causal machine…It now can be seen as a world of propensities, as an unfolding process of realizing possibilities and of unfolding new possibilities" (Popper 1990, pp. 18–19).

Dictionary approaches to science definition reflect two main themes: the arrangement of facts to show the operation of general laws, and the acquisition of knowledge gained through systematic methods (observation and experimentation; www.Dictionary.com). These lay definitions of science reflect the current struggle in the social sciences that signals a dramatic shift in paradigm from a theoretically deductive positivist perspective emphasizing reproducibility and generalizability to a more flexible, interactive, constructivist, historically and locally situated dynamic approach to science. Our goal is to shift the science of prevention to "partial knowing" in a dynamic environment and to argue for the use of measures and procedures that describe emergent processes and progress toward desired endpoints under specific contexts and under specific social conditions.

An historical perspective on the evolution of science as an approach to the solution of human problems situates it in 19th century rationalism and the development of Newtonian physics, which offered a mechanistic controllable view of the world useful to laboratory science and medicine, and to the rise of industrial capitalism (Tebes 2005; Wallerstein 2004). This approach to inquiry is dedicated to the development and testing of theories or externally derived propositions, using replicable objective measures and techniques, and established principles of sampling and quantification that control for nonrandom variation leading towards the development of generalizable laws of human behavior. This model of science was adopted by some of the social sciences, including psychology, sociology and economics. It held that disinterested scientists, uninfluenced by

social values, produce truth claims that constituted the only legitimate source of knowledge and could be tested only by other scientists with access to a canon of tools and procedures for the production of acceptable and believable scientific knowledge (Wallerstein 2004:22–23). Other biosocial science disciplines including sociology, biology, anthropology and geography, however, were more rooted in observational or empirical science and the generation of hypotheses, comparative case studies and local theories.

Post World War II convergence of developments in physics, ecology and the social sciences resulted the emergence of a new view of the world as "holistic"—a dynamic and interactive eco-social system in constant change. Complexity theory, a perspective first stimulated by the intersection of physics through chaos theory (Gleick 1987; Gregersen and Sailer 1993; Guess and Sailor 1993), and the social sciences through world systems theory (Wallerstein and Hopkins 1982), ecological theory (Bronfenbrenner 1979; Bronfenbrenner and Crouter 1983) and dynamic systems theory (Morel and Ramanujam 1999; Nowotny 2005b; Thelen 2005) brought with it a new set of theories, and concepts that are now shaping and connecting the ways in which laboratory, social, and historical science is conducted.

Complexity theory frames eco-social systems as consisting of multiple intersecting components and agents in constant interaction and ongoing problem solving and change (Houchin and MacLean 2005; Nowotny 2005a; Schneider and Somers 2006; Weidlich 2005; Winder 2007). Unlike mechanistic views of the world that seek for generalities that hold across time and place, complexity theory holds that constant movement can be understood best within time and place; thus historicity becomes central to complexity theory. Further, political, economic, social, and physical/environmental dynamics all can be seen as shaping both historical and current trends. Thus the current emphasis on interdisciplinary basic and applied research scripts as approaches to understanding health and other social problems is not accidental.

Nonlinearity and unpredictability are characteristics of complex dynamic systems (Scoones 1999; Winder 2007). The interaction of multiple components with history results in somewhat unpredictable processes and outcomes (Ermarth 1995; Jackson et al. 2005; Jackson 2005; Lansing 2003; Weick and Quinn 1999) and must be evaluated empirically (Leaf 2007; Leaf 2005). For this reason, evidence based practices in prevention science which may have been tried and shown to be effective in one location under one set of historical and contextual conditions cannot be assumed to be effective in another. They must be weighed and judged to be suitable based on local criteria, with the anticipation that the endpoints or results may be somewhat or altogether different. In nonlinear systems, alternative futures may be conceptualized and approximated but cannot be predicted (P. Jackson 2005; Lansing 2003; Manson and O'Sullivan 2006; Walby 2007). Computerized modeling (introducing multiple combinations of variables interacting under different conditions) may be useful in assisting communities to make what they perceive to be the choices that best approximate desired futures. But even modeling may not provide accurate pictures of what might occur in the "real world" because the correct variables may not have been specified, because it may not be possible to identify all of them, or because unpredicted new elements intervene to shift the direction of variable interaction (Capra 2005; Lansing 2003; Thelen 2005). One solution that has been utilized in confronting this scientific dilemma is combining science based modeling with "local ecological" or situated knowledge that is experiential, observational and practice-based. Local sources of tacit knowledge may become explicit and operationalized, producing better or at least different working models (Fisher 2000). For example, mathematical modeling and local knowledge have been combined in fisheries research where fisherfolk and scientists work together, using experiential knowledge and mathematically generated estimates to predict fishing stock, and establish ceilings on annual catches for lobster, snow crab, and other valuable resources (Davis and Wagner 2003).

The degree of proximity, density, intensity or multiplicity of different types of interactions among components also varies across systems. Network theory provides the basis for measuring these dimensions of a dynamic system. The characteristics of networks of agencies and agents have implications for the ways in which innovations and information flow and for how social or other interventions are introduced and diffused or disseminated (Booher and Innes 2002). For example, information may flow more rapidly but remain contained within dense and multiplex systems, whereas in systems that are loosely coupled, that is, connected through multiple weak ties, information may flow more rapidly across systems or subsystems (referred to as sub regions with a network) (Granovetter 1973). Sengir et al. argue that frequent communication strengthens network connections while infrequent use weakens them (Sengir et al. 2004) but the opposite also may be true depending on the nature of the communication. Applying network theory to understanding the ways in which levels and components or sectors of a community are interconnected and individuals interact to produce new knowledge and action is critical when framing any interventions and is even more important when implementing MLDSIS interventions since such connections can affect the flow of the intervention in a variety of ways (Cross et al. 2002; Houchin and MacLean 2005; Stoebenau and Valente 2003).

We can locate change in dynamic systems in multiple ways: via boundary intersects or points of conflict and confrontation, sources of information exchange, and problem solving; or via agents engaged in continuous interaction that evolves emergent new forms of organizational structures, or practices (Fischer 2006, 2008; Gorman et al. 2006; Lansing 2003; Smith and Conrey 2007). These so-called causes or "start points" can arise spontaneously or as a result of multiple strategic inputs. Multilevel interventions or interventions that "seed" the community with similar directed activities, especially when they derive from the interaction of internal agents and ethnographically informed outsiders, can act as strategic inputs (Sengir et al. 2004). Some examples of this process can be seen in the literature on the fight against genital mutilation (Babalola et al. 2006; Boyle and Carbone-Lopez 2006; Rosenberg 2004; Hernlund and Shell-Duncan 2007; Monahan 2007; Monkman et al. 2007; Prazak 2007; Reuters 2007), or where external and internal groups merge to push reluctant communities toward making changes in traditional ways of producing crops (Rogers 2004), In sum, dynamic systems illustrate unpredictability because change is constant, nonlinear and responds to multiple and interactive influences which cannot always be anticipated.

The view of science that emerges from and interacts with this perspective is also dynamic. It is based on systematic observation of ever changing and interactive natural and social phenomena using describable and replicable methods or processes to arrive at results in the form of local theories which can then be tested through comparison (Leaf 2007; Leaf 2005). This science is situated in history and place, recognizes the influence of value, intent and positionality, and generates incremental knowledge that can be formalized and tested repeatedly to respond to the probability of change across time and place. To avoid a complete scientific relativism, it is important to put into place a comparative approach to science that seeks for similarities and differences and tries to explain them using an interdisciplinary, situational and historical analytic framework similar to the comparative case study approach utilized by anthropologists and sociologists (Ames et al. 2000; Glasgow et al. 1999; Ragin 1987, 2000; Ragin et al. 2003). Ethnography offers our best means of describing and tracking change through organizational and individual interactions and illustrating pathways to differential, emerging outcomes that are observable but not predictable.

Ethnography

Ethnography is an approach to inquiry that involves several processes important to multilevel interventions in community settings. First and foremost, unlike other forms of qualitative research that are based solely on interviews with individuals (for example patients, or drug users), ethnography is conducted in communities (Schensul and LeCompte 1999). Usually the communities that ethnographers study are situated in time and space although some are virtual or global, connected through media and tele-and digital communication (Buraway et al. 2000). The ethnographic enterprise is a dance between immersion and reflection. Ethnographers immerse themselves in community and family life in the community of study, while at the same time reflecting upon and identifying units or "bits" of cultural practice and knowledge, and slowly integrating them into larger themes, patterns and explanatory models (LeCompte and Schensul 1999).

Ethnography may be carried out by individuals or by teams (Gerstl-Pepin and Gunzenhauser 2002). Regardless, good ethnography rests on relationships between the ethnographer and the study community (Agar 1986; Agar 1980). These relationships of trust and reciprocity, built over time, are the foundation for good ethnographic data collection. Local people with expert knowledge, with whom the ethnographer developed good relationships, are referred to as "key informants" or community experts with information to share and, at times, an interest in exploring the question along with the researcher. They may become members of the research team, sometimes as paid staff, and partners in the research process. Thus ethnography depends on intellectual, personal, and experiential engagement between researchers and community members (who may also be researchers) in communities in which research is conducted (Schensul and LeCompte 1999).

Ethnography also calls for the kind of engagement that results in understanding community processes, structures, history, rituals, practices, norms and beliefs through the eyes of residents. One of the responsibilities of the ethnographer is to find ways to represent the perspective of the people who are the subject of study, through their own eyes, narratives, and cultural products either through thorough immersion in the setting and the lives of the people, or through partnerships or both. To reach this point, ethnography involves long term involvement and face-to-face interaction with participant communities in order to understand on multiple levels how, with whom, where, and for what reasons new ways of thinking and social organizations emerge, activities, (including interventions), take place, and events unfold over time (Schensul 1985). Generally, ethnographers try to avoid imposing data collection approaches on respondents by depending on themselves as the primary instrument for data collection. Favored means of data collection are participant observation (observing cultural and social processes while engaging in them and understanding them through lived experience), and various

forms of in-depth interviews which resemble a dialogue (Bernard 1995; Huberman and Miles 1994). Other data collection tools including surveys are used as appropriate. Social and theoretical or explanatory validity are assessed via personal knowledge gained from experience in the setting, verification with ethnographic team members if the process involves teamwork, and discussions with members of the setting (member checks) on the other (Bernard 1995; Huberman and Miles 1994; Schensul and LeCompte 1999).

As ethnographers, either insiders or outsiders (Marriam et al. 2002; Minkler et al. 2002) enter into the lives of others, they must constantly renegotiate their identities, changing with the trusting relationships they establish and the new knowledge and understanding they acquire, while at the same time, maintaining a strong sense of self-hood and a measure of intellectual distance that provides the basis for continued questioning and analysis (Takacs 2003). Continuous engagement in an inner dialogue between learning through relationships and exposure, and identity, is the mark of a good ethnographer. Ethnographers, responding to the challenges posed by their identity markers or their "position" in relation to others, recognize that the information they collect and the opportunities they negotiate are closely linked to how they represent themselves, and how they are viewed (Takacs 2003).

Positionality calls for the recognition that what is learned or known is shaped by personal characteristics and their attributes, relationships among individuals in the study setting and characteristics of the setting (Harding 2004). Positionality is shaped by obvious markers such as race/ethnicity, language, and gender, and more subtle markers such as clothing, vocabulary, and accessories (everything from jewelry to choice of automobile or cell phone) and is negotiated from context to context depending on how these indicators are interpreted and how they affect responses. Diverse membership benefits research teams in multilevel, socially complex intervention situations. One reason is improved collaboration. A diverse group is more likely to be able to overcome communications barriers stemming from class, performance, positionality and other sources of difference, and to enhance the probability of establishing good relationships with different sectors of the study population. A second is the value of diverse perspectives in obtaining and analyzing data on a complex intervention, and interpreting and problem solving its meaning, its implementation and its role in interaction with the study community.

Ethnographic evaluators working in intervention studies often are required to collect systematic data on specific processes and outcomes, and will try to collect these data through their presence at meetings, social events, and on other occasions when intervention practices are organized and performed. The data ethnographers collect are usually qualitative but many ethnographers see their work as both qualitative and numerical, including surveys, elicitation techniques, mapping exercises and network analysis often used in understanding the relationships among organizations and other components of settings (Bletzer 1995; Hopson 2002; Ryan and Schwandt 2002). In addition to documenting intervention performance ethnographers seek to identify and explain discrepancies between interventions as planned and conducted, to document interactions among intervention components, to seek evidence supporting or contradicting social validity and acceptability, and to describe unanticipated or serendipitous consequences or outcomes. Ethnographic evaluators produce observations about the complexity and ever changing social context of an intervention, and the interactions of "units" (people, organizations and material culture) related to it. The ethnographic view of intervention evaluation is as emergent action in relation to changing context. That is not to say that intervention fidelity, defined as the degree to which the actual differs from the intended, cannot be assessed ethnographically; however, ethnography's best contribution is to find the unanticipated, the novel and the unexpected, in addition to documenting gaps between the expected and the actual. In the language of dissemination science, ethnography is efficient at describing the emergent processes of adoption, adaptation, implementation and sustainability (Glasgow et al. 1999; Green and Glasgow 2006). Thus ethnography, an approach to scientific inquiry used to gain holistic understanding of complex systems using interpretist methods (interpretations of "reality" through personal experience and observation) and empirical measures (measures external to self), is uniquely suited to gain understanding of multiple levels of intervention, the ways they interact and the shifting dynamics of the larger contexts and communities in which they are situated.

Community and Culture

Multilevel interventions are place-based and are usually situated in bounded geographic settings that may be referred to as local communities. Anthropology, community psychology and public health all utilize the concept of community to define their work. Further, many recent articles and books in the areas of public health and community psychology refer to "community based" research, that is to say, research conducted in community settings and usually together with various sectors of designated communities. This raises immediate questions about the definition of communities. Communities may be as large as cities or counties, as small as villages of <100 or virtually infinite if we speak of internet or virtual communities. The term "grounded community" can be used to apply to those

communities within which intervention researchers work, and which are located in socio-geographic space on the surface of the earth. Generally, social scientists include within the boundaries of "grounded communities" the residents and their networks, and the organizations and legislators, policy makers and regulatory bodies with which they intersect, and which often have power over some aspects of their lives. Communities have an identity recognized by most residents and other organizations both inside and outside their boundaries; they are characterized by historical continuity and change; they include assets and "liabilities", risk and protective factors, opportunity structures and describable links with systems beyond their boundaries which affect them and which they in turn affect on an ongoing basis. They are dynamic systems in interaction with others (Chaskin 2001; MacQueen et al. 2001; Shediac-Rizkallah and Bone 1998).

Generating a multilevel understanding of community history, sociogeographic and demographic composition, cultural and linguistic dynamics, social and political organization, health promotion history, points of friction, and potential partners, all necessary for furthering intervention research, is assisted by ethnography. Ethnography also offers the tools for gaining indigenous knowledge, and "cultural, social or historical" hooks or local meanings and behaviors that might provide the basis for socio-culturally situated interventions (Agar 1983; Rappaport 1995). Multi-level interventions are focused on change in social and cultural institutions and social relationships, as well as individual behavior. Thus any effort to introduce either an endogenous or exogenous intervention should consider which community resources should be involved, and whether and how they can and will contribute to multilevel change. These resources can best be discovered in partnership with community knowledge-bearers and change agents through ethnography as lived experience in local communities.

In addition to social organization, community members share many cultural understandings in the areas of communications, relationships, history, and language. These shared understandings derive from historical, ecological, political, economic and media forces as well as negotiated or co-constructed understandings among residents and other constituencies. They can be identified through the use of secondary sources (for example archives, newspapers, local media programs), interviews with community experts, and focused participant observation. Perhaps the best way of learning about shared understandings is to engage in various forms of participatory formative research that transform tacit knowledge of community cultural capital into explicit knowledge which can be used by participants as, or working with, interventionists to transform systems.

Though communities may share historical and cultural commonalities, at the same time, they are complex, consisting of various class and special interest groups. Historic and current relationships among these groupings are characterized by economic, social and political disparities sustained as a result of differential access to the tools of power. In complex communities there may be multiple cultural differences and disagreements, more conflict and competition, and ongoing efforts to negotiate and redress differences that cut across class and institutional boundaries. All of these factors have the potential to produce conflicts, contradictions and counterinfluences that must be addressed in multilevel interventions, and that increase the already difficult task of working toward the same end with partners at selected levels (Hyland and Bennett 2005).

Communities are internally connected via webs of relationships through which information, resources, and power flow and are exchanged. These exchanges and interactions are generally marked by differences in power and authority, making collaboration difficult and challenging (Wilder 1999). Externally or internally articulated structures of power and difference are likely to be intentionally or unintentionally repeated and reinforced within and across social levels. Multilevel interventionists should take care to avoid replicating these inherent historical, class and power differences especially when they are designed to empower or solve issues of disparity in marginalized communities. In this way, the exacerbation of new or longstanding differences can be avoided (Walby 2007).

In intervention science, current ecological language specifies the interaction of multiple levels in a community setting. Followng Bronfenbrenner, these are variously defined as *macrolevel* (larger structural factors such as policies and regulations, or media), *exolevel* (agencies, organizations, systems that affect individuals indirectly—are mediating organizations), *mesolevel* (social entities—peers, extended family, social service agency—that affect individuals directly) and microlevel (family, couple, kinship network) (Bronfenbrenner 1979; Bronfenbrenner and Crouter 1983; Trickett 1997). Most multilevel analytic and intervention approaches use ecological models to identify how factors at macro, exo and meso levels affect individuals and social groups. However, a critically important and often under-looked dimension of ecological theory notes that ecological systems are *dynamic* systems characterized by interaction among levels. Rather than attempting to control for other levels of influence, multilevel intervention leads us to introduce changes at strategically selected levels all of which are designed to move the designated system toward the same or related desired ends and are likely to have synergistic effects.

An ecological model offers many advantages in conceptualizing multi-level interventions. It helps to define the "social levels" and sectors within levels available for

involvement in an intervention. It reminds researchers that multiple sectors or components within each level must be recognized and studied in order to select like-minded partners and to identify sympathetic well as oppositional forces. It calls for an understanding of the ways in which institutions and organizations at each level intersect with respect to the desired change. Institutions like individuals hold standpoints (Harding 2006, 2004) that guide their missions, their financial and social resources, mission, interrelationships, community role, community capital, and the ways they gain and manipulate power must be understood to determine their potential for partnership (Jordan et al. 2005).

The notion of communities as multi-level systems in change is typical of contemporary social science .Theories accounting for the etiology of change have shifted from large scale external forces such as colonialization, revolution and evolution to acculturation/ accommodation and most recently to responses to globalization and the transmigration of labor, capital, information, media and technology, war and drugs (Buraway et al. 2000). Social change, once viewed as the introduction of new technologies to "innovators" or "opinion leaders" and diffused to others, is now seen as stemming from the interaction of "agents", that is individuals with agency, interacting across boundaries to solve ongoing problems at the local level (Fischer 2006; Gorman et al. 2006; Houchin and MacLean 2005; Lansing 2003; Smith and Conrey 2007; Tsoukas 1996). Situated problem solving both produces and is the result of tacit (informal or situated) knowledge, which when shared and articulated, becomes explicit and incorporated into a community's cultural repertoire. Thus, rather than asking how communities respond to change, and focusing our research on "change agents" or acculturation processes that introduce and promote change, we shift the question to how organization emerges from constant change and the role of local "agents" or actors who produce it (Gorman et al. 2006; Smith and Conrey 2007). Tsoukas and colleagues note that "change is the reweaving of actors' webs of beliefs and habits of action as a result of new experiences obtained through interactions" (Tsoukas and Chia 2002). Drawing from ethnographic research on organizations, we describe this process as cultural improvisation, or cultural problem solving (Forde et al. 2006). Hawe notes that cultural improvisation is ongoing and constitutes the environment within which any externally or internally introduced intervention takes place (Hawe and Shiell 2000). This view of communities and cultural constructivism has implications for MDSIS because it defines sources of innovation, and research design, and calls for a more complex understanding of outcomes and how to conceptualize and measure them.

Sources of Innovation

Organizational theorists and local knowledge advocates argue that the most important ideas and new information comes from those locations where front line problem solving is occurring. Front lines are the boundaries or fault lines across which communities and constituencies (individuals or groups with vested interests or important problems to solve) interface and confront difference. These fault lines may be found in many places, and at many levels, and can best be discovered through ethnography. Front line problem solvers may be outreach workers, teachers, community organizers, firemen, principals, mayors' assistants, or politicians depending on the issue in question. A planned intervention may be irrelevant to these agents because either it does not coincide with or respect tacit knowledge, or because it addresses a problem that these agents do not see as important. The identification and engagement of front-line problem solvers is necessary for effective multi-level intervention planning (Agar 2007; Hawe et al. 1997; Hawe and Shiell 2000).

A number of researchers focus on the construction of local knowledge through various forms of collective research. Rappaport sees local knowledge as a source of creative resistance in marginalized communities and suggest a collective narrative approach that creates a common sense of identity (Rappaport 1995, 2000). The use of narratives has much in common with feminist action research approaches (Fine and Torre 2006; Guishard et al. 2005; Mankowski and Rappaport 2000) and with building sociocultural and historical capital (Arnold and Fernandez-Gimenez 2007; Cilliers and Wepener 2007). They note that local narratives may be multiple, and that master narratives that reduce the capacity for resistance must be understood and considered as well as those that empower. The narratives themselves can result in the construction of new knowledge and through it, new forms of identity and personal empowerment. They also have the potential to identify points of intervention or action at multiple levels. Under the proper conditions, for example, a participatory research and multilevel action agenda can emerge and move toward implementation based on a collective narrative approach.

Participatory Action Research (Berg et al. 2002; Brydon-Miller et al. 2008; Schensul and Berg 2004; Schensul et al. 2002; Schensul et al. 2008) provides a model for emergent change. This approach engages residents of marginalized communities in the use of ethnographic research methods to identify local knowledge, assets and liabilities, risk and protective factors, using an ecological model. This tool enables community action researchers to identify and examine their own theoretical model portraying sources of resistance, resources, assets and

problems at multiple levels, use interviews, sorting strategies and surveys to test their theoretical model, and build their own local knowledge base and multilevel intervention approaches. PAR work is intended to result in multilevel social change strategies and can be successful given sufficient time and inputs.

Schensul and Berg describe participatory action research partnerships developed at the Institute for Community Research, and designed to support the development of informed community activists by helping them to use local knowledge to guide social action. The programs used a PAR approach to build on participants' tacit knowledge or cultural capital. At the same time the facilitators introduced critical analytic skills and research tools to enable participants to increase their critical and reflective capacity (self or first person research), to join forces with like minded others to combine their own knowledge (tacit cultural understandings and interpretations) with empirically derived data, to understand and interpret fundamental social problems affecting their communities (group or second person research), and to take social action to address these problems by changing or transforming impeding structures (institutions, policies, programs) (Schensul et al. 2008). Participants in these programs were able to initiate efforts to change educational and gender-discriminatory policies, and to offer new voices to political dialogues related to education, economic development, and social and linguistic integration of new immigrants to Connecticut. PAR and related resources and tools for facilitating indigenous innovation and activism at the local level should be considered in the construction of multilevel interventions (Arnold and Fernandez-Gimenez 2007; Fine and Torre 2006; Freidenberg 1991; Guishard et al. 2005; Romani et al. 2007).

Van Willigen (2005), a community development anthropologist, adds historicity to the notion of local or indigenous knowledge, that is, understanding the role of history in promoting or eliminating cultural beliefs, norms and practices and community institutions, by which he means publicly valued procedures and arrangements for getting things done. "Getting things done" occurs because organized groups of people have financial, customary or legal foundations, and rules for proceeding and training to carry these activities out. These institutions solve local problems (Van Willigen 2005).

In a similar vein, some transformational theorists focus on different forms of indigenous social, historical, and cultural capital (or assets, local knowledge and institutions) as having value as a foundation for local resistance, identity formation, resource development, accrual of power, and local change (Gillies 1998; Hawe and Shiell 2000). These theoretical frameworks provide suggestions and tools for identifying and/or co-constructing "levels", "sectors", institutions, and other resources that may already be engaged in community problem solving. Identifying and analyzing them in terms of their role in promoting or inhibiting change is critical in the development and evaluation of multilevel interventions.

Methods for Identifying Levels

A major issue in multi level intervention development is the identification of the components or "levels" of the "system" that are most conducive to bringing about change. Several specific sets of tools have potential for contributing to this process. These include "community readiness" assessments, assets mapping, collective narrative construction/reconstruction, and various forms of participatory action research that draw on ecological modeling. Community readiness tools explore the readiness and capacity of communities and organizations to "accept" specific science based preventive interventions such as DEBIs and EBIs (Miller 2003). Assets mapping, an approach developed by Kretzmann and McNight (Kretzmann and McKnight 1995) focuses on identifying community resources that can be helpful in planning and community change efforts, mainly individuals, associations and institutions. The Kretzmann and McNight approach evolved as a counterpoint to the view that poor communities and low income residents were liabilities and took the position that such communities had, and could identify and organize, their own assets to solve their own problems. Assets mapping identifies community leaders and sources of knowledge and action, community organizations, features of built environment, components of the political structure, businesses and other institutions (all forms of social and environmental capital) that can play a role in indigenous development. There is no rule of thumb for estimating how many "assets" should be included in a multilevel intervention. Perhaps the best strategy for researchers is to use formative ethnography to study key individuals, and organizations that have demonstrated support for the issue over time, to examine their behaviors in relation to the issue and the degree to which they are networked, and to test their engagement in initial meetings that lead the way to more formal collaborations (Averill 2003).

Ethnographers learn to become "insiders" through rapport building and systematic exploration of the local history and political economy, language, forms of social interaction, institutions, political issues, community populations and divisions, and health and mental health concerns. This process is immensely important in identifying appropriate levels and sectors of central relevance that offer perspectives, resources, and political will to a multilevel intervention. Ethnography can be conducted in a non-

participatory or participatory manner. At minimum in the early stages of intervention research, it should focus on identifying "allies" and possible sources of resistance to a specific approach to research or intervention and on building effective partnerships that will build on local knowledge while avoiding the exacerbation of power differentials or existing community divisions (Schensul and Schensul 1992; Schensul 1985).

Comparative Design and Matching at the Community Level

Multi-level interventions introduced in one community are likely to "look" different in other communities where policies, community alliances, agencies and population composition are different. Even if we could "match" at all levels chosen for the intervention, communities do not share the same dynamics; and complex systems change in different ways and at different rates. For this reason we prefer to avoid the trap of assuming that two communities "matched" on demographics, or other factors are identical and that community randomization as implemented in a group randomized controlled trial controls for random effects.[1] Instead we utilize two concepts: comparison matching and qualitative comparative analysis. Comparison matching focuses on whether the communities include structures, roles, processes that though different, meet similar community needs. The theoretical rationale for the selection of intervention levels will determine which elements should be comparable across communities based on similarity of function. For example, if a core component of an intervention is a media campaign, each intervention community must have the capacity to carry it out in one way or another. Thus the "same" intervention, that is, the same essential components or functions conducted in different communities through different mechanisms identified by partners and ethnography should be able to contribute to similar outcomes. Fidelity can then be redefined as consistency in applying theories of selection and implementation with respect to policies, community alliances, agencies and their missions, and population culture and dynamics adapted to produce similar outcomes under differing conditions. Qualitative comparative analysis utilizes a somewhat different strategy (Ragin 1987). Rather than choosing communities that are similar in terms of functional components related to the intervention, a comparative case analysis rests on the comparison of two communities that differ on a level-specific characteristic considered theoretically and practically important to the intervention but are similar (or matched) in other aspects. The comparison addresses the question of whether or not that characteristic contributes or detracts from anticipated intervention outcomes. For example, communities might vary in availability of infrastructure to support a multilevel AIDS intervention focused on female condom use; one might have an AIDS alliance, the second none. The research question would address the degree to which the presence or absence of an AIDS alliance made a difference in reducing HIV risk exposure across the two communities by increasing access to FC use.

Level-Based Theorizing and Measurement

At each level, multi-level interventions must be theorized, and should be culturally and structurally congruent. The term congruent refers to similarity of purpose and conceptual framework guiding a variety of activities and actions. Partnerships must be established with representatives associated with each identified level to arrive at the "best" theories and strategies, that is, those strategies most likely to reinforce or complement approaches at other levels so that processes and outcomes triangulate. Changes to be observed or measured in schools or community organizations will differ from those at the individual or policy level, but the content and direction of these changes are, ideally, synergistic. In this approach, the intervention acts as a "blueprint", theorized, interpreted and implemented differently by actors at each level. Ethnographic "process evaluation" describes and contributes to reshaping the intervention activities toward a common goal, and attempts to document interactions (synergistic or otherwise) among levels as well as outcomes anticipated or achieved by level. Changes in individuals or groups are likely to occur incrementally and unsystematically across the system and can best be measured using time series designs as well as with more standard baseline post-intervention measures in a GRCT design.

Sustainability

What Defines Sustainability?

In a comprehensive overview, Scheirer suggests that effects of an intervention can be evaluated as continued benefits of the intervention after it is over (sustained effects on participants), continuation or routinization of program activities within implementing organizations (sustained effects on organizations), and the continued capacity of the community to create and conduct new programs when technical assistance, researcher involvement, coalition

[1] This does not apply to smaller "communities" within larger municipal settings, for example, buildings, schools or libraries in cities or towns. These may be treated as comparable in a group randomized controlled trial model, for some purposes, and as unique, or systematically different, for others.

support or other external support systems are no longer in place (sustained effects on communities) (Scheirer 2005). She notes that most interventions are not conceptualized as multilevel; thus the assessment of sustainability at each of these levels (individual, organizational and community) is neither conceptualized clearly nor linked.

Individual behavior change interventions reported in peer reviewed journals show short or at best intermediate term positive outcomes that tend to decline over time. Crossover studies show lower continuing effects in intervention groups and reduced effects in trained controls (August et al. 2006). These studies, like many others, suggest that continuing external inputs are required to maintain desired intervention levels especially at the individual level. Sustained individual effects across communities that have participated in community-wide change strategies been reported primarily for multilevel public health interventions that require single actions, such as handwashing, using bednets to prevent malaria, or removing standing water to eliminate breeding grounds for the mosquito that carries the dengue fever virus (Cairncross et al. 2005; Coon et al. 2003; Romani et al. 2007). The relative success of these interventions is based on their cost effectiveness, limited need for continuous monitoring, endorsement by public officials and incorporation into local cultural practices.

Complex interventions that call for cognitive, social, political and economic changes in dynamic systems are more difficult to sustain. Here the notion of sustainability is questionable, because the conditions under which original results are obtained are likely to change over time, as a result of multiple circumstances including wars, migration, policy changes, internal disputes, organizational and staffing shifts, urban development/displacement and the development of new medications that successfully treat deadly diseases or prolong life or quality of life. In an effort to address these challenges arising from the constant change paradigm, researchers concerned about sustainability mention several critical issues, including self renewal and community and organizational capacity building. Below we highlight these factors.

Problem Solving and Self-Renewal

Critical to sustaining a successful interventions is the capacity to engage in indigenous problem solving that includes three primary components: self-evaluation and monitoring to assess whether the intervention continues to be well received and effective and when and how to modify it to continue that trajectory; the ability to monitor and evaluate the environment to determine when the intervention needs to be changed to fit new conditions; and finally, the capacity to address the new conditions with a new approach. These last two, which are illustrated by Rapkin and Trickett's Comprehensive Dynamic Trial models (Rapkin and Trickett 2005), are the most important and the most difficult to achieve. They require committed and visionary leadership, sufficient resources, constant training and self-evaluation, and multiple level inputs and openness to self-reflection, monitoring and acceptance of feedback (Gillies 1998; Romani et al. 2007).

Capacity Building

Many researchers believe that one of the best ways of ensuring sustainability is to build community or organizational capacity for the conduct of health or social interventions. At the community level, capacity building involves the ability to model and monitor the results of an intervention and to identify changes in the environment that result in new problems to be addressed. Further, if the challenges are structural, the capacity to organize and participate in movements is required to bring about policy changes at a more global level. Participatory Action Research and assessment tools (assets based and social capital) offer communities tools and skills to engage in monitoring, advocacy and new development.

At the organizational level, capacity building refers to the ability to understand the requirements and implementation protocols of evidence based interventions, and to match them with the needs of constituencies. It also includes the ability to analyze and change, if necessary, the structural barriers to implementation within an organization such as low wages, staff turnover, struggle for financial survival, categorical funding for programs that stand in the way of wraparound services, and inadequate training and ongoing technical assistance and support at all levels (Braa et al. 2004; Chaskin 2001; Hawe et al. 1997).

Van Willigen's framework for evaluating community resources from the perspective of their ability to contribute to overall community development provides some guidance in considering multilevel sustainability potential. The question he asks social science interventionists is not "how can we assess existing capacity to accept, conduct and maintain a specific intervention" but instead: "what is important in assessing the capacity of an intervention resource to contribute to (indigenous) community development?" Van Willigen identifies the following factors: (a) the political position and standpoint of the institutional resource (the source of the intervention). This determines the degree to which the institution is subject to external control; (b) the goal orientation of the resource; a broad rather than narrow set of goals allows for greater community involvement; (c) the degree to which the resource focuses on individual vs. community (multilevel) welfare; individual level intervention approaches alone weaken

community bonds; (d) duration of the resource—the longer the time period allocated for the intervention, the more likely it will be able to contribute to community development; (e) the connection of the resource to community organizations—the greater the connection, the more likely the contribution to community development, provided the source is not allied closely with powerful forces that have the potential to undermine community interests or goals. This approach, the purpose of which is to enhance indigenous development and community building especially in minority or marginalized communities, is quite different from assessing community capacity to accept an exogenous evidence based intervention. It reflects Trickett and others' concept of "the learning community at the community level" (Trickett and Ryerson Espino 2004)—Scheirer's "third level" (Scheirer 2005).

The role of community residents in sustaining evolutionary or transformational change is often mentioned but poorly documented in the intervention literature and very few discussions of sustainability focus on the mobilization capacity, collective self efficacy or cultural embeddedness required at the local level to change and maintain changes in structural or organizational dynamics.

One significant indigenous multilevel effort that arose through the efforts of local citizens or community residents is exemplified by a 10 year nation wide AIDS intervention in Uganda called "Singing for Life", which was developed by a group of local performers, spread through networks to other organizations and informal groups, and came to be supported at the national level by the ministry of health and the president's office (Barz 2006). This example illustrates the capacity of citizens to innovate based on local cultural forms, form social networks in their own and other communities, and move from there to joining a national movement in a context of political will to bringing about macrolevel change with local effects.

Barz work highlights Van Willigen's caution that community reliance on external development or intervention resources may be either empowering or disempowering and the possibilities of disempowerment and/or dependency engendered through reliance on external resources should always be considered. A case in point is the U.S. environmental movement, which flourished when based on volunteer support but lost the flexibility to advocate with increased foundation and federal funding that defined project directions and limited the voices of change (Brulle 2000).

Most science based interventions rely on external funds and the conditions of funding generally do not support continued resource allocation after the intervention is over. Foundation, state and other funders that prefer to fund "their own" programs (including other evidence based programs) rather than those tested by researchers in the local community. At the same time, some economists are beginning to discount the notion that interventions, however, "simple", can always be self-sustaining. Several have shown that even if based on external/internal partnerships, externally funded interventions are not locally financially sustainable, leading them to argue that if nation states or other political units prioritize an intervention as critical for public or social health, it should be paid for or otherwise supported on an ongoing basis (Kremer and Miguel 2007). One good example is pre and post test HIV counseling, which, in the U.S. has since the early 1990s, been publicly required and financially supported.

Barring other options, another view of sustainability in a dynamic system is more congruent with the dynamic nature of communities and more consistent with Hawe's view of interventions as insertions into community life. It deconstructs the components of multilevel interventions and traces their evolution ethnographically over time. Sustainability might then be redefined as the availability, use and translation /accommodation of intervention concepts, partnerships, methods, products, processes and feedback loops in the community. Studying sustainability of effect among organizational personnel, for example, would involve identifying whether they utilize and even expand intervention components or elements. For partner organizations it would involve observing over time whether they and the individuals associated with them continue to work together toward the same intervention ends. The individual practices of intervention participants might be followed to see whether and how they have continued, expanded, adapted and distributed the results of interventions to others. Finally, most interventions and intervention teams are time delimited, but the organizational and group relationships established through the intervention based on commonality of interest may continue in new configurations over time. Identifying the diffusion of intervention benefits in local communities can be done best when researchers have long term commitment to social change in local communities over time. Given changes in staffing, funding sources and commitments, policies and organizational practices, and community membership, sustaining these elements may well be the most sustainable outcomes of an effective intervention.

Finding Sustainability in Dynamic Systems

In this paper, we have examined and considered the relationships among several core concepts underlying multilevel social science interventions—science, community and culture and sustainability. We have argued that multilevel community based interventions are supported by a dynamic view of science that is historically, geographically

and socially specific and situated within an integrated set of theories derived from physics, ecology and social ecology.

We also have argued that MLDSIS locates interventions in ongoing socio-ecological systems and have suggested that one of the more efficacious ways of bringing about systemic change is by introducing comparable change strategies at multiple levels simultaneously. A major benefit of a multilevel intervention is its ability to focus targeted intervention strategies upon multiple key "levels" or sectors at the same time within a defined community system thus enhancing the likelihood of a desired outcome. This is based on the general theoretical assumption that there is an important though uneven relationship among levels, sectors and cultural domains and that some form of "system consistency" in cultural and structural rearrangements as various levels occurs as the intervention takes hold and a new dynamic equilibrium is established.

Swerissen and Crisp support this view that interventions should be carried out at the individual, organizational and policy levels, and discusses the relative advantages of intervention at each level (Swerissen and Crisp 2004). They note that neither individual, organizational nor policy level changes alone can bring about desired change. They argue that we need culturally appropriate parallel interventions that affect risk conditions (structural and social factors) and risk factors (individual factors) simultaneously. Introducing an inappropriate level—specific intervention is likely to result in no effect or a negative effect. Thus careful attention should be paid to introducing the proper intervention at each level and to conducting the research necessary to do so.

Multilevel dynamic systems intervention science is necessarily participatory insofar as it requires the engagement of sympathetic individuals and organizations or institutions at each social level. Careful identification of partners contributes to systems consistency in process and anticipation of outcome. Further, if the goal of the intervention is to reduce disparities and population marginalization, it is critical to select partners committed to this end in order to avoid undermining the intervention process. The identification and incorporation of these entities requires a form of participatory research in which intervention researchers work together with organizational informants and community experts to seek and interview potential collaborators, observe their actions and subsequently engage them in intervention planning and implementation. Participatory research can also contribute to ongoing intervention improvement by enhancing feedback loops. It can explain how and why desired benchmarks are achieved, and monitor the environment at all levels to assess when the intervention needs to adjust or adapt to new conditions.

Many questions remain to be answered. For example, is intervention efficacy affected by initiation at only one level (with the broader goal of affecting other levels), vs. simultaneous intrusions on multiple levels. When intervention proceeds at multiple levels simultaneously, how can the challenges of synchrony and synergism be addressed to ensure maximum effect and transformation? Do effects at different levels show uneven sustainability over time, and if so, what are the consequences for overall persistence of change and/or problem solving? The collaborative approach, engaging local communities, is especially attractive since demonstrated vested interest is anticipated to lead to higher levels of sustainability when the formal intervention is over. What are the limits of collaboration and partnership with respect to vested self interest when limited resources, lack of capacity and changing conditions may erase all of the persistent effects of an introduced intervention?

Above and beyond appropriate interventions, sound leadership, community commitment and high level of capacity, many researchers report that the single most critical factor contributing to short term sustainability is not community or organizational uptake, but the continued allocation of public or private resources to the maintenance of an intervention. This is contrary to the expectations and hopes of most international and national intervention funders who generally anticipate that interventions can be integrated into local or national settings. Under what conditions should governments make decisions for the public good to continue an intervention despite community inability to sustain it.

To move forward the field of MDSIS, we have acquired sufficient tools, experience and resources to identify multiple levels and strategic points of intervention in communities. We are moving toward the redefinition of intervention science to recognize that differences across units of analysis are an asset rather than a statistical liability and to accept repeated case study designs as a viable way of testing community level interventions. We are moving toward acceptance of the notion that alternative research designs are necessary and that the methods and tools of ethnography, time series design, network research, and systematic feedback loops can assist in evaluating these interventions. Finally we need to strengthen and further the field of sustainability studies. In a rapidly changing global environment with variable local effects, we need to assess whether and what structures and cultural practices including indigenous innovations are sustained and sustainable over time, and whether and with what human inputs they transform to adapt to changing circumstances.

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