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ORIGINAL PAPER

Theorising Interventions as Events in Systems

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Abstract Conventional thinking about preventive interventions focuses over simplistically on the "package" of activities and/or their educational messages. An alternative is to focus on the dynamic properties of the context into which the intervention is introduced. Schools, communities and worksites can be thought of as complex ecological systems. They can be theorised on three dimensions: (1) their constituent activity settings (e.g., clubs, festivals, assemblies, classrooms); (2) the social networks that connect the people and the settings; and (3) time. An intervention may then be seen as a critical event in the history of a system, leading to the evolution of new structures of interaction and new shared meanings. Interventions impact on evolving networks of person-time-place interaction, changing relationships, displacing existing activities and redistributing and transforming resources. This alternative view has significant implications for how interventions should be evaluated and how they could be made more effective. We explore this idea, drawing on social network analysis and complex systems theory.

Keywords Intervention · Complexity · Social networks · Ecological · Community · Context

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Introduction

An interchange in the 1980s captures a history that has repeated itself several times since in the field of prevention. When the Stanford Heart Disease prevention project was first being described and discussed, the lead investigators were criticised for using the word "community" to describe their intervention while actually relying on theories of behaviour change from individual psychology to power their thinking. The critics were asking for a cognisance of community and community-change processes (Leventhal et al. 1980). Missing the point completely, the Stanford team replied that given that individuals were the ones having heart attacks, they were happy with the approach they had adopted (Meyer et al. 1980).

As it happened, and is well known now, the Stanford Heart Disease prevention project and others modelled on it are counted as some of the failures in the history of the promotion of heart health (Susser 1995). In reflecting on this, the Stanford investigators concluded that "communities are dynamic entities" and as a consequence their approach should have been different at the outset (Fortmann et al. 1995). Sadly, they did not concede that this is what their critics had pointed out all along.

Population-level prevention, based on individual-level theorising, has thrived nonetheless. It could be argued that a lot has been gained. For example, improvements in physical activity and diet have been achieved by simple messaging by telephone (Eakin et al. 2007). Reductions in sexually risky behaviour among adolescents have been achieved with computer based interventions (Kiene and Barta 2006).

But overall, for several reasons, there is unease and dissatisfaction with the idea that conventionally conceived behaviour change interventions should function as our

main avenue to promote well being. Changes have been often shortlived (Schensul 2005). Approaches have not been reliably effective in reaching the most disadvantaged groups, leading to charges that health inequities might inadvertently have been increased by employing conventional methods of health promotion (Hill et al. 2005). Third, when researchers or practitioners stop to ask communities what they are actually interested to work on, rarely does the problem that researchers happen to be focussed on (e.g., heart disease prevention) come top of the list. More acute issues to do with social conditions invariably prevail e.g., drugs, crime, safety, environment, opportunities for children (see Higginbotham et al. 1993). Finally, creeping into the literature about health and well-being now is a concern for what could be understood as weak prevention, that is, the recognition that modest or negligible effects have almost become the norm in any large scale programs trying to improve health (Zaza et al. 2005). The costs are high and the marginal benefits, if any, are low.

More is Different

We argue in this paper that weak prevention might be an inevitable consequence of programs that rely too heavily on individual-level theorising, in which whole community or system-level change is conceived simply as a matter of "aggregating up".

"More is different" said Nobel Prize winner Phillip Anderson (Anderson 1972). Anderson was talking of the way physics had become preoccupied with describing and classifying individual particles, actions and interactions up to the scale of atoms. But, he argued, if you throw a group of atoms together things become quite different. This explains why chemistry is a discipline of its own and not just a branch of physics (Watts 2003). We think the same fundamental shift in thinking is required in the field of change-processes in human populations.

We start this paper by painting the context within which theorising about community interventions has been recently re-energised but still falls short of what we think is required. We then examine how the adoption of a dynamic, ecological, complex-systems approach could influence research and development in community interventions.

Lessons Drawn When Programs Fail

Large scale, population-level intervention projects were launched after the early Framingham studies showed that some major causes of death were potentially preventable through lifestyle change (Dawber et al. 1957; Truett et al. 1967). The "big name" model interventions to prevent heart disease (e.g., North Karelia, Stanford, Pawtucket, Minnesota, Heartbeat Wales) of the 1980s and 1990s were celebrated initially with much fanfare, but things went off the boil when intervention effects were shown to be minimal or modest (Susser 1995). More recently, the US Task Force on Community Preventive Services for all types of disease and disability has lamented that in 50% of the interventions reviewed there was still insufficient research evidence to make any practice recommendations (Zaza et al. 2005). Investigators have looked to three areas to explain the problem of weak prevention: inadequate ways of involving communities; faulty research methods; and impotent theory.

While the primacy of community is no strange idea to the readers of this journal, in public health the idea that involving community members in the development of interventions may increase intervention relevance, effectiveness and sustainability has become more uniformly accepted only in the last two decades (Thompson et al. 2003). Now, communities are more likely to be actively engaged in intervention design, and methods like participatory action research with community-led interventions are becoming more widely accepted and funded (Israel et al.1998; Minkler and Wallerstein 2003).

A propensity to blame the research methods (such as quasi-experimental designs and randomised trials) came when high-profile, well-designed community interventions failed to show an impact but investigators felt that it was likely that the intervention was successful (Tudor-Smith 1998). Strong secular trends were seen to be responsible for the inability to disentangle effects (Thompson et al. 2003). Much energy also went into debates about traditional research designs in medicine (such as randomised trials) and their suitability for community settings (World Health Organisation 1999).

But it is in the realm of theory where there may be the most to learn and gain from past failures of community interventions in the field of public health. The investigators of large field projects have become more determined to get inside the "black box" of interventions to better specify the underlying logic (or theory) of health promotion interventions in order to make the interventions stronger (Pearson et al. 2001a, b). This has seen the spawning of various models such as theory of change (MacKenzie and Blamey 2005), intervention mapping (Bartholomew et al. 1998), and theory-based evaluation (Chen 1995) partly as ways of pinning down causal pathways and also to better understand precisely what activities are implemented and how outcomes result. Researchers adopting this approach have got "inside" their interventions and developed intricate logic and implementation maps of messages sent, classes held, skills training acquired and so on (Dusenbury et al. 2005). This includes, for example, precise mathematical

illustrations of how easily an intervention is diluted and potential effects decreased if sufficient numbers of program participants do not pass through all the required check points (Hardeman et al. 2005; Eldridge et al. 2005).

The interrogation of intervention logic is welcome and potentially productive. But rather than attempting to think or do things differently, it could be argued that all that has been achieved is more meticulous ways of doing the same thing (see for example, Bartholomew 2006). What we might be witnessing is what Henry David Thoreau described as "improved means to unimproved ends". Instead, we suggest that the interrogation of theory should occur in a manner far more fundamental than currently supposed. Borrowing the words of the physicist Anderson, we should be looking more at the chemistry and less at the atoms.

Taking an Alternative, Dynamic, Ecological Systems View

An ecological perspective recognizes that individuals are located within a broader social context (Stokols 1996; Green and Kreuter 1999). It is hard these days to find a health promotion program that does *not* claim to take an ecological approach. But for the most part ecological is simply taken to mean that the intervention has multiple strategies directed at multiple levels e.g., child + family + school or possibly, worker + workplace + community. Other than the idea that "the more levels, the better the effect", there is little theory put forward about how these levels impact the unfolding of the intervention or how they affect intervention outcomes.

By contrast, in community psychology, ecological thinking represents a view that is more than just about levels. Schools or worksites are recognised as ecological-systems that follow the principles of system dynamics (Trickett et al. 1972, 1985; Trickett and Birman 1989). This dynamic, ecological-systems perspective stresses the importance, among other things, of linkages, relationships, feedback loops and interactions among the system's parts. For example, a crucial element in any ecological system is its activity settings. Activity settings are time-and-space-bounded patterns of behaviour e.g., a school basketball game, a parent–teacher meeting, a dance, an English literature class (Schoggen 1989). In each activity setting, one can identify features such as roles, people, symbols, time, funds, and physical resources (O'Donnell et al. 1993). Ecological theories about behaviours are based on the relationship of these features to each other. Take for example the ratio of roles to people. If there are more students in a class than meaningful roles to share around, students behave badly. To reduce the delinquent behaviour one either increases the roles in the setting, or reduces the number of students (Barker and Gump 1964). This taps the theory of "staffing" in a setting, with under-staffing or over-staffing leading to predictable experiences and consequences. The essential point is that the theory driving the intervention is about the dynamics of the context or system, not the psyche or attributes of the individuals within it. This underlines an important contrast between the contributions of individual health psychology and community psychology.

The same contrast (between understanding parts and understanding wholes) has surfaced in the literature on interventions in public health. Investigators have used the term "complex interventions" to describe projects with many interacting constituent components, with a large number of discretionary behaviours or actions required among the intervention agents and "recipients", a large number of groups or levels targeted by the intervention, a large amount of flexibility in tailoring the intervention and high degree of skill required among those delivering and receiving the intervention (Medical Research Council 2008). Evaluating such interventions requires sophisticated causal modeling (Hardeman et al. 2005; Eldridge et al. 2005). But our sense is that this literature does not take explanation and understanding of complexity far enough, because it still locates the intervention in its constituent parts. The discourse is also complicated by different uses of terminology in the field, with some investigators equating "multi level" interventions with "complex" interventions (Riley et al. 2008).

We contend that adherence to the origin of complex systems theory (in physics) matters (Rickles et al. 2007). Further, the most significant aspect of the complexity possibly lies not in the intervention per se (multi faceted as it might be), but in the context or setting into which the intervention is introduced and with which the intervention interacts (Shiell et al. 2008). Taking ecological systems like schools, workplaces and communities and adding the complexity lens might alert us to dynamics in the change process that have not been previously understood. To do so might even point to ways to improve intervention effectiveness.

A Systems-Level Way of Conceiving Community-Level Interventions

Community psychology is no stranger to systems-thinking, as the articles in a recent edition of this journal attest (Foster-Fishman and Behrens 2007). But the adaptive properties of the systems in which community psychologists work mean that it is not possible to separate out system-level change from non-systems-level change as

objectives (Foster-Fishman et al. 2007; Parsons 2007). If the properties of the system are not acknowledged from the beginning, then the system's tendency towards self-organisation will often work to negate one's best efforts (Tseng and Seidman 2007). In recognition, we argue that embracing the systems-approach requires us to reconceptualise the notion of intervention. We propose that a useful new heuristic in intervention research is to think of interventions as events in systems that either leave a lasting footprint or wash out depending on how well the dynamic properties of the system are harnessed.

The systems-approach starts first and foremost with studying and understanding the context. One should attempt to understand the nature and diversity of activity settings in the system as well as the strategic positions occupied by key players (e.g., teachers and students in a school, managers and employees in a workplace) (Foster-Fishman et al. 2007). This draws attention to the networks of social relationships that make up the system, the variety of roles that exist or can be created within those networks, the status conferred on those roles, the symbolism, and the meaning that different actors draw from the intervention event.

Interventions could be seen as ways to create new roles, to elevate particular symbols, to bridge structural holes within and between networks and to increase opportunities for interaction and exchange. The "creation of settings" is foundational thinking in community psychology (Sarason 1972) but very little research has focused on setting-level change (Tseng and Seidman 2007) and empirical work with interventions has never really mapped the dynamic process by which the creation of settings comes about.

We offer ways to capture system-level change brought about by any particular trigger intervention. Four specific courses of enquiry are illuminated for intervention research and development.

(1) Uncovering How the Intervention Couples with the Context

There is an interactive arena in which an intervention "couples with" the existing context (Trickett et al. 1985). Some of the best work in this field has come from the study of program sustainability or institutionalization within an organization which yields insights into how the procedures of a new program or intervention become part of a host organisation's routine. Yin conceptualised how programs become embedded in their organisational contexts along two dimensions (Yin 1979). These are the extensiveness of the program across the organization—how far across the system is the program evident, and the intensiveness of its integration into routine practice.

So, talking about a worksite stress management program, for example, does it exist on the organisation's website? Is it in the orientation package given to new staff? Does it get mentioned in Board minutes? Is it mentioned in regular staff meetings? Does it exist in the conversations in the staff canteen? Do some staff have it as their job to deliver the program? Do others operate the appointments or booking systems? Is there a time and space regularly allocated for it to take place? Is it part of the organizational mission? Is it specially funded on its own budget cycle (dependent on an external agency) or is it funded as part of the regular budget cycle of the organisation?

These tracers or markers have been used in retrospective reviews of program sustainability (Goodman and Steckler 1987). They could be used prospectively in intervention research also. The aim would be to generate a list of key activities, settings or events at the beginning of an intervention and then to monitor how the intervention intrudes or "shows up" in these sites, settings and events using observational, and for the most part qualitative, methods documenting for example (changes in) conversations, signs and symbols, and behaviours. Hence, the way an intervention comes to seep into or saturate its context becomes a way to view the extent of its implementation.

(2) Tracking Changes in Relationships

Networks are social structures that both constrain and facilitate behaviours (Wellman 1982). The actor's position in each network (e.g., central or peripheral) and the characteristics of each network itself (e.g., loose ties among actors or dense ties among actors) help to determine one's experiences and opportunities. Network analysis (a quantitative technique) can be used to track changes in structural relationships across time, such as whether the network becomes more sparse or cohesive and whether there are changes in the strategic position of particular people (Wasserman and Faust 1994).

Some health promotion interventions are specifically designed to use and change relationships, such as training general practitioners to counsel patients in lifestyle change (Ashenden et al. 1997) or education programs to reduce smoking in schools based on the idea of working through peers (Campbell et al. 2008). These examples capitalise on the credibility of the information source to send a particular message. Interventions also use relationships to reach people who might not otherwise come into contact with the health system, such as lay helping interventions for cancer screening (Earp et al. 1997). Latkin and Knowlton provide examples of how network structures can be targeted as part of intervention design in HIV prevention (Latkin and Knowlton 2005).

A third way to think about and factor in relationships in interventions, is to consider relationships among people or relationships among agencies as part of the pre-intervention context-assessment process because this might end up playing a role in predicting why interventions work better in

some settings than in others or why some interventions are sustained while others wither (Hawe et al. 2004a). Tracing the impact of an intervention on the density of collaborative networks, as the direct consequence and objective of an intervention is also reported in the community intervention literature (Singer and Kegler 2004).

There is also a fourth way to think about relationships within a community intervention, and that is how some of the new technologies associated with them are introduced and used by actors to create new relationships and new meanings. This takes community intervention into the realm of actor network theory, that is, the idea that new concepts start to get tied to material things through their use by actors. These material objects become active in the way that meaning is transferred through the network (Latour 2005).

For example, some community interventions develop health information kits and the traditional way to measure their success would be in terms of their distribution and the extent to which they were read by the intended target audience (Flora et al. 1993). But the lasting value of introducing an intervention which requires a practice nurse to explain the content of a resource kit that is taken away and read by a new mother may be that it elevates the nurse's role and changes his/her status and relationships with other members of the primary care team. This change in the status of the nurse, symbolised and actively communicated through the package, may then have beneficial flow on effects, generating new opportunities and roles. This is how researchers in the management sciences use structuration theory (Giddens 1984) to understand how innovations within organisations take hold (Orlikowski and Robey 1991), that is, through the repeated circumstances under which the new role is practised.

(3) Focussing on the Distribution and Transformation of Resources

Resources are the "raw material" that processes for bettering the human condition draw upon. Examples of these resources are people (e.g., their skills, the way they frame ideas, their knowledge), events (e.g., for connecting people, celebrating achievements, reflecting on progress), and places or settings (Trickett et al. 1985) which provide opportunities for behaviours and activities to be carried out. Interventions have the potential to transform people, events and places, changing the networks that link all three in the process. They create new roles and redistribute resources across the network. Practitioners build these assets intuitively in interventions. With prospective measurement of the dynamic changes taking place, feedback of this information and coaching, the creation of these resources could be developed more strategically and therefore more effectively.

(4) Assessing Activities Displaced

Traditionally, intervention research focuses on whatever new activity or technology is introduced into a community, school, worksite or organisation. Effects are attributed to the new intervention. But it is the activities that are displaced that might more truly account for changes in the outcomes observed. Understanding this would be vital for monitoring and improving the intervention or replicating what one thinks it might be in another setting. We have yet to find any study that systematically describes what people in their school, community or clinic stopped doing to participate in a new intervention. Yet this might contribute substantially to the so called "intervention" result.

Implications

Several implications follow from viewing interventions dynamically, in contrast to the conventional approach.

How Fidelity of an Intervention is Defined

The first implication is a change to the notion of what an intervention looks like ideally. When a health promotion intervention is a conventional program package, intervention fidelity requires that it adopt a standardized recognisable form that looks essentially the same in every site. By contrast, when an intervention is conceived dynamically, as an event (or series of events) in a system, then the process and sequence of change could be the same in all sites, performing the same purpose or function, but the form might be different. The intervention would adapt to different initial conditions in each site. This need not compromise intervention fidelity provided the intervention still adhered to its theory e.g., the survey-feedback-action cycle familiar in community or organisational development; or the principles of empowerment or social support interventions (Rappaport et al. 1984; Israel 1985). In other words, rather than the conventional view where the *form* of an intervention has to be standardised and replicable across sites, with this way of thinking it is the *function* of the intervention that is standardised, so that the form can vary across contexts (Hawe et al. 2004b).

A Means to Quantify and Define Capacity Building in Network Terms Over Time

The second implication that derives from this alternative way of viewing interventions is the opportunity for capturing the full benefits of an intervention, in particular success tied to terms like "capacity building". When an intervention is about diffusing a particular attitude, or

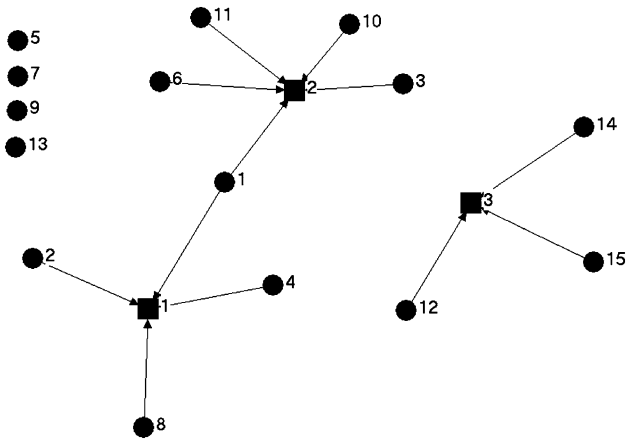

Fig. 1 Fifteen people connected (or not) to three events/activity settings in a community agency. Squares are activity settings/events. Circles are people

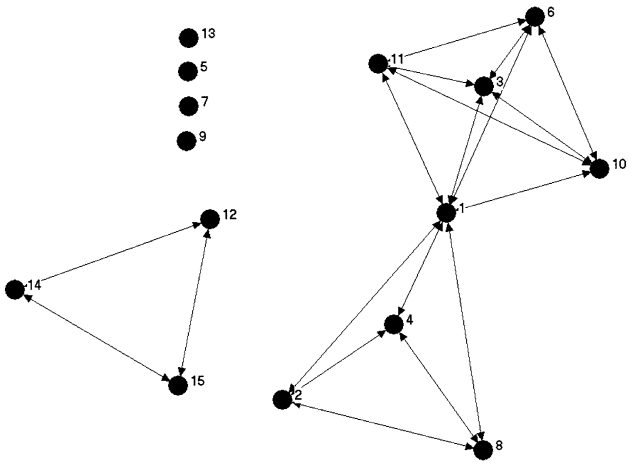

Fig. 2 How the pattern in Fig. 1 converts to a person × person network. Circles are people

health practice across a population, then success is defined by evidence of its spread and uptake. The more people do it, the better, generally speaking. But when interventions are viewed more dynamically, in the way we have suggested, then success could include enablement, or improvement of the structural position of the people and organisations that comprise the system's network, assuming that building competence or capability is part of the intervention objective.

Figures 1, 2, 3 and 4 illustrate hypothetically how an intervention transforms the structure of the network of people in a community agency by the creation of new events and activity settings using social network analysis (Wasserman and Faust 1994) demonstrating greater density over the evolution of time. At baseline, 15 people are connected to various degrees by three events or settings (e.g., a training course; an executive committee; an after-work tennis club). This is represented in Fig. 1, which shows that one person attends two of these events or settings (person 1), ten people attend one, and four attend none.

A social network of "affiliations" is created by considering who attends the same events (Wasserman and Faust 1994). This appears in Fig. 2. It shows that four people are considered 'isolates'. Three are in a clique in that they attend one particular event or setting only and the rest are connected with each other but in a structure that illustrates the high degree of "betweenness centrality" (commonly known as gate keeping) for person 1 (Freeman 1979). In network terms, person 1 has more power than the other people and he or she holds an important 'bridging' relationship in the network.

Now imagine an intervention that, for example, sets out to reduce post natal depression in the community and requires all people in the agency to read and use new

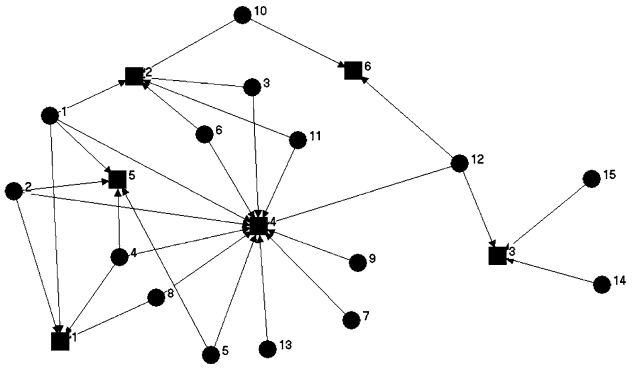

Fig. 3 How the addition of two additional activity settings and one technology confers new connections for people. Squares are activity settings or technologies. Circles are people

guidelines on screening and dealing with post natal depression of new mothers. Let's suppose that only 12 people comply with this and report that they regularly use the guidelines in their practice. While not an event or a setting in the sense defined by activity settings theory (Schoggen 1989; O'Donnell et al. 1993), the guidelines can be thought of as a technology which is constantly defined and refined in its recurrent use. The rules and interpretations of this use constitute its critical meaning and value in the workplace change process (Orlikowski and Robey 1991). By supposing that the users of the guidelines constitute a resource sharing network (even if they don't ever meet face-to-face under this rubric), we are drawing on actor network theory (Callon 1986). That is, people have affiliations with each other through a common resource that comes to create a particular meaning through repeated use by them. Played out over long time periods, for example, we might see how such technologies create particular embedded cultures. People's use of the technology along with their own position and penetration of the organisation

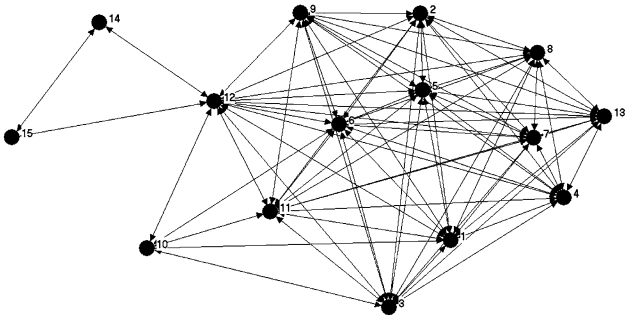

Fig. 4 How the additions in Fig. 3 correspond to a transformation of the person × person network. Circles are people

thus represent a cognitive resource and their common use of language around the technology represents a "semantic network" (Monge and Eisenberg 1987).

A further three people form a task group to work with the city council on policies that might make life easier for new mothers (e.g., privileged parking spaces in shopping centres; breastfeeding facilities). The task group is another activity setting. Another example might be the formation of a mothers' liaison and action group and a different three people in the agency get involved in this. Adding these three developments (two new activity settings, and one new technology in common use) to the existing agency leads to the pattern of connections in Fig. 3. Figure 4 again computes the new ties made between people as a result of these three new events. It can be seen that many people's position in the network structure is now different. Many more people have power in the sense that their new positions, created by new relationships, give them better access to more social resources (e.g., information, practical aid, attitudes, skills, affirmations, language, ways of framing ideas, reasoning processes). We have shown this graphically only, but social network analysis quantifies (scores) these changes.

An intervention could be thought of as various events and opportunities. It might introduce new procedures that require some staff to meet more frequently. New task groups could be created to address local needs. New celebrations may be held to acknowledge local achievements. The creation of new connections changes people's social positions (some people becoming more central others less central; others become connected for the first time). These connections create new opportunities for the exchange of information, material resources and emotional support (what the sociologists call "opportunity structures"). This, in theory, enables particular people to act in new ways, a form of enablement or capacity building. In this way the change process of the intervention has led to the emergence of a new structure that potentially embeds, rather than fades away over time, depending on the feedback mechanisms that encourage and reward action. We are suggesting that this new structure for action, in this instance to prevent post-natal depression, could represent one "whole", or system-level aspect of the intervention effect, more than simply the units of change within the system—the knowledge, attitude or skill changes in the staff or the prevalence of post-natal depression in the community (though of course these matter too). The structure potentially represents a particular new capability and the by-product is other vital new connections (that would be made both within the original network and outside of it) that continually place the actors in the network in a position to access resources and opportunities for adaptation and growth.

We base this argument on the work of Monge and Contractor (2003) whose research within computer-based communication networks goes so far as to suggest which structural forms of networks are best suited to different purposes—such as exploring for new information, or exploiting existing resources, or mobilizing action, or acting together or facilitating bonding among members. It links to how the network is being theorised—for example whether theories of self interest would be more salient in some situations than theories of contagion or theories of collective action (Monge and Contractor 2003). With multi-level, community based interventions we do not know as yet which type of structures work best under which circumstances, but work is heading that way. Valente and his colleagues, for example, have recently shown that while the assumption is usually made that network density among agencies or people increases collaborative advantage, this is not always the case (Valente et al. 2007).

A Means to Use the Insights to Potentially Build or Boost Intervention Strength

The third implication from viewing interventions dynamically affects how one would improve the reach and effectiveness of the intervention. Dynamics systems thinking invites one to "harness complexity" (Axelrod and Cohen 2000) with strategic investment of energy in particular system parts and processes. That is, we can seek to amplify the effect of the intervention by tracking changes in relationships (networks) prospectively, and using the information generated to steer the intervention in strategic directions. This means enhancing positive feedback loops—the ones that move the system towards the desired change—and counteracting negative feedback loops—the ones that work in the opposite direction. In our empirical work we have tracked how community development workers create events and enrich settings over time (Hawe and Riley 2005). This includes the language of the project,

the ways of framing the problem it is addressing, the symbolic meaning attached to particular elements of the intervention, and the value that it might have over existing routine ways of working. Pairing this analysis with longitudinal network analysis would allow one to observe and track "epicentres" of new structural formation, to feed this information back to key players and to coach patterns in particular ways, e.g., to create events that might connect hitherto separate parts of a network (i.e., bridging structural holes).

A Reason to Invest in Longer Time Frames for Tracking Intervention Effect on Desired Outcomes and More Context Level Assessment

The fourth implication of thinking of an intervention as an event in a dynamic complex system affects they way we would capture an intervention's effects on health outcomes or the desired outcome of interest (Shiell et al. 2008; Hawe et al. 2009). This includes allowing for longer time frames for follow up to appreciate that change in complex systems happens non-linearly, i.e., there may be long periods when little appears to be happening then suddenly large changes can occur: known as a phase transition (Rickles et al. 2007). Evaluation also includes much more observation, analysis and understanding of the pre-intervention context. We foresee a shift away from the techniques and dominance of "program evaluation" and a move towards a new science and practice of "context evaluation". This could involve a new profession of scientist-practitioners working like "in-house ethnographers"—helping schools, communities and worksites to appraise and harness opportunities to use new technologies, opportunities and ideas to improve system-level capability.

Concluding Remarks

Researchers and practitioners in health promotion have become accustomed to multi-component interventions. But receiving all the right parts in the right dose and order may have insufficient value for understanding effects or the notion of "complexity" invoked by the use of the phrase "complex interventions". Intervention effects might be the result of more dynamic processes (multiplication rather than addition, non-linear relationships, feedback loops, interactions). Conventional program logic in health promotion, which is very much focused on the health messages and uptake of the intervention's component parts by people or units within the system, might miss the significance of the interaction and dynamic beyond this.

"Complex" might be more appropriately ascribed to the system into which an intervention is introduced. Interventions might be best thought of as a time limited series of events, new activity settings and technologies that have the potential to transform the system because of their interaction with the context and the capability created from this interaction. People in the after-work tennis club might talk about, and perhaps complain about and begin to modify, the new practice guidelines, for example. People in the city council workgroup might start using material they were exposed to in the staff training program. The "intervention language" and meanings might start to seep and saturate into these new pathways of interaction created by the intervention. To make an intervention truly "an event" in the existing system, that is to meet the definition of an event being defined as "something *significant* that happens" then the intervention would need to change the future trajectory of the system's dynamics. To be an effective intervention this change in direction must lead to positive outcomes.

What we offer here is not a comprehensive theory of community intervention. Neither do we discuss or add to vital aspects of good practice, such as how communities themselves are involved in interventions and the research process (Minkler and Wallerstein 2003). Building upon the principles, methods and metrics discussed in the previous edition of this journal devoted to systems-thinking (Behrens and Foster-Fishman 2007; Hirsch et al. 2007; Janzen et al. 2007; Kreger et al. 2007), we point to some new ways of thinking about dynamics that might enhance current approaches to theorising and measuring change. While we have emphasised the need for prospective, longitudinal monitoring and measurement, the role of time in this will require special theoretical consideration (Koehler 2003).

The idea leads to the possibility that that in the future all interventions might be seen as system-level events that produce particular types of mathematically recognisable constellations of structural forms according to the type of intervention and the context. We are now using network structures to both assess and explore how we might coach change processes in organizations and communities (Hawe et al. 2004a; Hawe and Ghali 2008). Whether this leads to more effective and more sustained interventions is to be tested. Improved health outcomes, more equitably distributed, maintained over long time frames is the goal.

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