

Perspectives

Unpacking complexity in public health interventions with the Actor–Network Theory

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Summary

This article proposes a sociologically informed theoretical and methodological framework to address the complexity of public health interventions (PHI). It first proposes three arguments in favour of using the Actor–Network Theory (ANT) for the framework. ANT: (1) deals with systems made of human and non-human entities and proposes a relational view of action; (2) provides an understanding of the intervention–context interactions and (3) is a tool for opening the intervention's black box. Three principles derived from ANT addressing theoretical problems with conceptualisation of PHI as complex systems are proposed: (1) to focus on the process of connecting the network entities instead of their stabilised form; (2) both human and non-human entities composing networks have performative capacities and (3) network and intervention shape one another. Three methodological guidelines are further derived: (1) the researcher's task consists in documenting the events that transform the network and intervention; (2) events must be ordered chronologically to represent the intervention's evolution and (3) a broad range of data is needed to capture complex interventions' evolution. Using ANT as a guide, this paper helps reconcile technician and social views of PHI and provides a mean to integrate process and effect studies of interventions.

Key words: Actor–Network theory; complex system perspective; public health intervention research.

INTRODUCTION

Actor–network theory (ANT) has been developed by Bruno Latour, Michel Callon and others since the 1980s. Originally, ANT was developed as a sociology of science focussing on understanding the production of scientific facts and technology. Because this theory developed a renewed vision of the social world, it evolved

into a grand sociological theory known by the name of sociology of translation or ANT. Latour (2005) proposed an in-depth presentation of this theory in his classic book *Reassembling the social*. ANT is now recognised as a useful conceptual tool for appraising complex situations and analysing the production of change. The theory is increasingly used to understand

change in complex systems such as health care, where it has been employed to study the introduction of technology or of new strategies for service improvement (Ramiller, 2007; Cresswell *et al.*, 2010, 2011; Bleakley, 2012; Stoopendaal and Bal, 2013). It offers a powerful tool for opening up the black box of public health interventions as it provides a means for mapping the genesis of interventions in the form of a networking process (Bisset and Potvin, 2007; Timpka *et al.*, 2009; Young *et al.*, 2010; Duff, 2011; Roke *et al.*, 2012; Rushton, 2014), while showing how effects are produced (Correa and Domènech, 2013).

More than an analytical tool, ANT is a methodology for understanding the world (Latour, 2005; Broer *et al.*, 2010a; Bleakley, 2012). Given that it achieves its full heuristic potential when applied to concrete situations, we thought that if we could successfully apply it to the analysis of population health intervention it would provide useful (and much needed) theoretical and methodological frameworks for population health intervention research (PHIR). In this article, we set out a conceptual framework and methodological guidelines we have derived from ANT for investigating PHI based on both our own field studies on public health interventions and other researchers' studies that have employed ANT to unpack the black box of complex interventions. We first justify the use of ANT for the analysis of PHI; we then present our ANT-based framework for (complex) population health interventions, followed by a series of methodological guidelines derived from the framework. Finally, we discuss the usefulness of this work to public health research and practice.

THE APPROPRIATENESS OF APPLYING ANT TO THE ANALYSIS OF PHI

PHI addressing social determinants of health at a population level is still an innovative field in public health practice. It challenges traditional public health knowledge, especially in the formulation of intervention theories that needs to incorporate social determinants and actor mobilization for social change (Potvin *et al.*, 2005). Such interventions are complex systems (Hawe, 2015) that mobilise actors from various sectors (e.g. education, transportation, work, urban planning, welfare) and spheres (public, community, philanthropic, private), at the community and government levels, together with a variety of non-human entities such as specialised knowledge, resources, communication technology and so forth. Such disparate assemblages of entities are called hybrid actor-networks (Callon *et al.*, 2001).

Interventions of this type must not be exclusively conceived of as techno-scientific objects, meaning knowledge-based activities developed and implemented in response to problems (Hawe, 2015). Instead, they must be conceived of as evolving objects that take form and transform in response to the contexts in which they are implemented (Potvin *et al.*, 2001; Poland *et al.*, 2008; Hawe, 2015). This view is in line with the conceptualization of interventions as systems, which focuses on the appraisal of the whole rather than its parts, emphasizing relationships, interactions and feedback loops between the various components and between the system and its context (Hawe *et al.*, 2009). Although it is always possible to focus on specific areas or subsystems, such as the different levels of action, strategies and resources involved, conceiving PHIs as systems provides a framework for problematizing relationships between interventions and their contexts, and how such relationships transform them both (Poland *et al.*, 2008; Potvin and McQueen, 2008a; Shiell *et al.*, 2008; Hawe *et al.*, 2009; Potvin and Clavier, 2012).

Focusing on the dynamic and recursive interactions between an intervention and its context leads to examining the connections between the various elements of the intervention and context, the network they form and the evolution of that network. This causes the observer to pay attention to interactions between the various entities—human and non-human—comprising such networks, their converging and diverging interests, their mutual influence, and the various actions undertaken by intervention providers or beneficiaries. From this perspective, intervention constitutes a strategy for enabling actors to change roles or create new ones, establish or strengthen connections within and between existing networks, create new networks and mobilise new resources, with the aim of producing changes in context.

PHIs addressing social determinants of health at a population level are still in need of theoretical general frameworks to provide adequate support for innovation and transform practices. Meanwhile, leaders and researchers in the field have called for theories elucidating the roles of social actors, their agency and associations, and the opportunities and constraints that exist in the contexts in which they interact (Potvin, 2005; Willis *et al.*, 2007; Hawe *et al.*, 2009). Contemporary social theories offer relevant frameworks for addressing the shortcomings in public health interventions aimed at producing social change, especially the under-theorization responsible for slowing down the production of general knowledge about the processes at work. Three arguments support the pertinence of using ANT to analyse PHIs as processes of social change. Firstly,

ANT suggests a relational view of action; secondly, it conceives of the context as being defined by the actors and their actions; and thirdly, it allows for the investigation of how effects are produced.

ANT is a powerful theoretical tool for studying PHIs in that it proposes a relational view of action. It locates humans together with material and technical objects inside a complex web of associations. It conceives of actors as performing actions in association with other actors. Focusing on actors, ANT encompasses and scrutinises the large network of connections supporting or restraining action. This perspective is well suited to complex population health interventions that often involve partnership and intersectional action, while assembling a wide range of entities, whether material—such as technical devices and resources—or social, such as organizations (Bilodeau *et al.*, 2011; Potvin and Clavier, 2013). It is not the actors per se that comprise the focal point of ANT but rather the connections between them through which they act. Interventions are thus seen as systems of actions in the form of networks (Latour, 2005; Cresswell *et al.*, 2010, 2011; Van Herzele *et al.*, 2011). This is in conformity with Hawe *et al.* (2009)'s view of interventions as networks of events.

The second argument in favour of ANT is that it promotes the conceptualization of context in relation to networks of actors and their actions. Social actors are constantly positioning themselves and their actions in relation to their context, identifying the universe in which they act, its contours, scale, and make-up, all of which evolve through their action. The researcher's task therefore consists of following and documenting the evolution and constant reassembling of network components (Latour, 2005). Instead of context being conceived of as a backdrop for networks, intervention contextualization is understood as being the by-product of networks (Andrews *et al.*, 2013). Thus, a researcher employing ANT would view contextualisation (i.e. the intervention in context) as a jumping-off point for understanding a situation, conceiving of it in terms of connectedness and the web of connections linking the entities involved in the situation. In network analysis, entities only acquire meaning and importance with regard to their connections (Latour, 2005; Callon and Feray, 2006; Andrews *et al.*, 2013). Contextualisation thus consists of identifying the various relevant components in a situation (social actors and their roles, physical objects in the form of material and financial resources, and symbolic objects in the form of scientific or experiential knowledge, values, norms and rules), analysing their attributes, strategic positions and power relationships, points of convergence and divergence with regard to the situation in question,

and what is at stake for them, and distinguishing areas of stronger and denser connections.

The third argument for the relevance of ANT to the study of PHIs is that it is a powerful theoretical system for opening up the black box of interventions (Bleakley, 2012). It allows for investigation of the production of effects, i.e. the complex process by which PHIs act and transform the context in which they are implemented. Documenting how intervention effects are produced remains a challenge for public health intervention research (Potvin and McQueen, 2008b). ANT offers a solution to this problem in that it provides an appropriate analytical framework for capturing actions operated through interventions, and makes it possible to reconstruct the various connections through which interventions change contexts and impact population health. The ANT-based analytical approach helps illustrate how effects are produced by connecting various entities (social actors, ideas, facts, resources) that act collectively in a network, and then document the chain of events that produces new connections leading to observed effects (Callon and Ferrary, 2006; Cresswell *et al.*, 2010, 2011; Correa and Domènech, 2013).

Paying close attention to the processes involved in producing effects contributes to a more comprehensive view of the complexity of PHI. ANT assumes that relationships among and between actors (both human and non-human) in an emerging network are mostly unpredictable and affect social environment in ways that are often unexpected (Cresswell *et al.*, 2011). ANT however suggests that strengthening connections within a network leads to a better organised network and that the predictability of a network's behaviour (effects) increases with its level of organisation (Latour, 2005).

ANT-BASED FRAMEWORK FOR PUBLIC HEALTH INTERVENTION RESEARCH

Among the numerous principles founding ANT we have identified three as the most important to the study of PHIs. First, ANT focuses on the connections between heterogeneous entities that make up a situation rather than on independently existing entities. It is concerned with the process of assembling social connections rather than their stabilised form. Thus, it considers 'an actor [to be] what is made to act by many others' (Latour, 2005: 46). Actors can only act in association with others and in constellations that give them the possibility of acting (Mol, 1999; Latour, 2005). Therefore, in the context of PHI, ANT concentrates on the processes responsible for producing the effects of interventions, based on the premise that observable changes are, in fact, the end result of completed processes. For example, the

development of a tobacco control policy requires actors from different domains to connect with one another and mobilise scientific evidence in advocacy actions in order to influence the public discourse in such a manner as to promote the restriction of smokers freedom so as to convince policy makers to act accordingly (Breton *et al.*, 2008).

Second, one of the foundational proposition in ANT is the principle of symmetry which essentially rejects the dualism between human and non-human entities. As a consequence, ANT affords human and non-human entities in networks the same treatment. This means that both human and non-human entities are considered to be capable of agency, depending on how they are associated within a given network. Non-human entities' agency is granted to them by human entities that activate them within a network (Potvin and Clavier, 2012). Consequently, ANT examines what objects make humans do as well as what humans make objects do, using the same conceptual repertory (Callon, 1986; Latour, 1987; Latour, 2005; Callon and Ferrary, 2006). Thus, in an area such as PHI, in which social actors (humans, organizations, institutions, etc.) are at the forefront, ANT would highlight both the performative capacities of non-humans entities, such as scientific evidence, expert knowledge, financial resources and regulations, as well as human agencies in shaping PHI. For example, recommendations concerning the plain packaging of tobacco products are based on evidence that cigarette packages themselves influence choices among certain groups (British Heart Foundation, 2011).

Third, another consequence of the principle of symmetry is that humans and technologies they produce are intertwined, and they cannot be understood independently from one another. Applying this principle to public health intervention as technology (Lehoux, 2006), this means the sociotechnical network and the intervention shape one another. The intervention is made possible only to the extent that it is supported by a sociotechnical network. In turn, the network is gradually constructed around the intervention. The intervention develops through the construction, expansion and strengthening of the network. (Callon and Latour, 2006). Thus, ANT offers a new way of understanding innovation in PHI, as well as their sustainability and dissemination. For example, the routinization of a programme within an organization requires linkages between elements from the programme and the environment to be strengthened at the expense of other competing events (Pluye *et al.*, 2004).

Central to ANT is the concept of translation, which refers to the linkage operation that connects disparate

entities—humans, things, new ideas, interests, values, specialised and lay knowledge, financial resources, institutions, regulations, etc.—in a situation. These hybrid collections of connected entities are called sociotechnical networks. Translation is the process by which networks are created, expand, and act. They act through the creation, reconfiguration, strengthening of connections and expansion of a sociotechnical network that connects new actors, resources and knowledge, resulting in the development of innovative solutions.

The translation process consists of four non-linear operations (Callon, 1986). *Problematization* involves the identification and connection of entities that are relevant to the situation at hand. It consists of assigning the entities roles and interests related to the situation. It also includes identifying problems, as well as potential solutions and controversies. The latter means the confrontation of differing views that actors in a given situation may hold and that are tied to their role and interest. Problematization evolves over time through interactions and controversies within the network (Broer *et al.*, 2010a). *Interessement* is the development of convergence in a network through the negotiation of roles and interests (Akrich *et al.*, 2002). It involves actors deploying strategies and mobilizing new entities in order to rally others to their own problematization. *Enrolment* is the product of successful interessement. It is the alignment of actors' interests based on their acceptance of roles as defined through negotiations. Enrolment implies certain shifts in actors' positions (actor displacements) and the closure of controversies. *Mobilization* consists of achieving a critical mass of connected actors able to coordinate their actions, thereby testing the solidity of those connections and the capacity of spokespersons to act and speak on behalf of the broader network. A certain level of solidity is required for a network to acquire sustainability and the capacity to act (Potvin and Clavier, 2012). Once actors have been enrolled, the network may stabilise for a certain amount of time and produce results (Latour, 2005; Andrews *et al.*, 2013; Stoopendaal and Bal, 2013).

In order for networks to operate and produce adequate solutions, new roles must be proposed to relevant entities and accepted by them. Commitment to new roles involves actors assuming new identities, which necessarily produces controversy (Potvin and Clavier, 2013). The notion of controversy is central to the translation process. Controversies link together and enmesh the techno-scientific and political contents that make up the issues facing actors (Lascoume, 2002). Solving controversies is essential in order to develop collaboration within a network. It is the closure of controversies

among actors that creates agreement among them and strengthens the network, stabilizing the intervention. Controversies are solved through translation by the addition of knowledge, other viewpoints and argumentative elements, as well as by the strengthening of existing connections and the enrolment of relevant new actors bringing new knowledge and resources necessary for action (Sénécal, 2012; Potvin and Clavier, 2013). Solving controversies consists of concerned actors striving to elaborate new, more robust solutions that would allow them to improve their cooperation while satisfying their own interests, at least in part (Callon, 1986; Callon, 1988; Bilodeau *et al.*, 2002; Latour, 2005; Akrich *et al.*, 2006). It should be noted that different networks pursuing disparate or opposite goals may compete for allies, institutional endorsement, public support and resources, at a particular time and place (Young *et al.*, 2010).

ANT also includes the concepts of mediator and of displacement and inscription into social or material forms that act as intermediaries in sociotechnical networks. Translation is operated by mediators, who are actors having the capacity to displace other actors thereby creating new connections that prompt changes in the network's entities. Displacements are the result of negotiations and persuasive actions through which actors manage to gain adhesion from others, reorganise connections, and shape the network (Latour, 1987; Correa and Domènech, 2013). As opposed to mediators, whose actions transform networks, intermediaries are entities that 'transport meaning or force without transformation' (Latour, 2005: 39). Such inscriptions—i.e. documents, devices, trained individuals or money (Callon, 1991; Stoopendaal and Bal, 2013)—circulate among the network's actors, stabilizing agreement and making innovations sustainable and capable of diffusion and dissemination. Dissemination involves connecting the interventions with other networks in which they are to be adopted (Callon and Latour, 1986).

ANT-DERIVED METHODOLOGICAL GUIDELINES

As shown above, ANT provides a powerful theoretical framework that offers solid foundations for interpreting interventions as they are developed, interact with their context, produce effects, and are sustained and disseminated. It may be used as a methodology for opening up the black box of PHI in that it elucidates the way in which a wide range of entities are linked together and displaced to produce social change. Three methodological guidelines have been derived from ANT as relevant to PHIR: developing a system of inscription to follow actor networks, adopting a chronological ordering of

events and making practical decisions during the field work, and using a broad range of data sources.

Firstly, the researcher's task consists of following and documenting transformations in sociotechnical networks, their actions, and the context in which this occurs, and analysing how the actors themselves define what is going on (Callon, 1986; Latour, 1987; Broer *et al.*, 2010a, b; Potvin and Clavier, 2013). Drawing on the concept of inscription (Callon, 2006; Latour, 2007; Potvin and Clavier, 2012; Stoopendaal and Bal, 2013), the researcher develops a system by which data and initial interpretations and analysis may be recorded in a material form that aggregates and synthesises information. Such system must include specific tools designed for following the evolution of the actor-networks, their intervention and context. These systems of inscription capture reality and help create meaning and knowledge. They shape the interpretation of situations under analysis by organizing data in the sense of ANT. They make it easier to manage and synthesise vast amounts of information, and permits thoughts, analysis under construction and primary results to be expressed in compact form. This type of system also facilitates the sharing of thoughts with stakeholders and practitioners during collaborative research or for collective reflection.

The second methodological guideline is the adoption of a chronological ordering of events, as ANT focuses on processes and processes evolve over time. This makes it possible to record PHIs as they develop (for data collected prospectively) or have developed (for data collected retrospectively). Consequently, it entails adopting the position of 'the researcher following the thing' (Cresswell *et al.*, 2011; Van Herzele *et al.*, 2011), i.e. making practical decisions about objects to be investigated and methods during field work rather than only a priori, based on the evolution of the process and the research objectives.

The third guideline is the use of a broad range of data at different system levels to capture the complex ways in which PHIs evolve, instead of planned data collection such as planned one-shot interviews with stakeholders—as Latour stated: 'Everything is data' (2005: 133). The various recommended ethnographic methods and types of longitudinal data are as follows: (i) observational notes taken during events (meetings, planning days, team-building sessions); (ii) logbooks kept by board members, managers or practitioners throughout the intervention; (iii) interviews conducted at appropriate times; (iv) government documents, internal administrative documents (strategic plans, progress reports) and intervention tools; (v) media (local and national newspapers, websites) and ephemera, such as letters, mails, contracts, meeting agendas and reports.

IMPLICATIONS

A systemic perspective that conceives of PHIs as transformative processes in complex systems opens up new possibilities for the creation of scientific knowledge relevant to public health planning. Having the necessary conceptual and methodological frameworks for capturing and interpreting observable manifestations of ongoing processes is a prerequisite for achieving this aim (Potvin *et al.*, 2010; Petticrew, 2011). The initial challenge is the development of a theoretical understanding of public health intervention, how it works and produces change (Datta and Petticrew, 2013). ANT offers a comprehensive framework for the analysis of complex systems of change. It provides a framework based on a general social theory for interpreting empirical data and making sense of PHIs. The theoretical and methodological frameworks presented in this article help capture the observable manifestations of social processes that take place during PHI, connecting them to a larger body of knowledge on similar social processes. This perspective is highly relevant in light of repeated calls for more comprehensive (high level) theories of change pertaining to such interventions (Larsen, 2001; Barnes *et al.*, 2003; Auspos and Kubisch, 2004; Potvin, 2005; Potvin *et al.*, 2005; Willis *et al.* 2007; Hawe *et al.*, 2009).

Anticipating and observing changes at the various levels at which they occur is another challenge to understanding and theorizing complex systems of actions. Such complex systems have properties that pertain to the system as a whole, and data must be gathered on multiple levels with tools designed for this purpose. This type of methodology is considered a prerequisite for the study of such interventions (Shiell *et al.*, 2008; Datta and Petticrew, 2013), and equipping PHIR with a system of inscription such as that proposed by ANT would be an appropriate means of achieving this end. Such systems are comprised of diverse sources of data concerning the sociotechnical network, the intervention and the context in which it is implemented. All of these are necessary to capture changes in the system as a whole. Furthermore, complex systems of change require research designs that focus on the intermediate changes that act as preconditions of system-level change, such as movements in the positions of key actors in the network (Shiell *et al.*, 2008). This prerequisite is adequately met by ANT-derived theoretical and methodological frameworks, especially the emphasis on the processes by which changes are produced.

Finally, to address adaptivity and feedback processes in complex systems requires an adaptive methodological approach in order to follow actors as they redefine their

action as well as any planned or unintended consequences (Shiell *et al.*, 2008; Datta and Petticrew, 2013). The methodological principles of ANT foster adaptive and longitudinal methodologies consisting, on the one part, of following actors and their actions so as to capture the chains of events that occur in complex systems, regardless of whether the events result in changes, planned or otherwise; and on the other, of making decisions regarding methods during field research rather than simply a priori. This sort of research position is well suited to the less predictable nature of change in complex systems, as well as to the different levels on which such change can take place.

Adaptivity and feedback processes in complex systems underscore the fact that knowledge about interventions is generated by practitioners as well as by intervention researchers. Complex systems are governed by feedback that may transform interventions. Agents in these systems are thoughtful, and capable of self-monitoring. They correct their courses of action in response to feedback (Hawe, 2015). Thus, research methodologies that are founded on the co-production of knowledge are more appropriate to capturing this reality than traditional designs that suppose a distant researcher. This implies a reciprocal practitioner-researcher relationship consistent with the researcher's epistemological position.

CONCLUSION

Many difficult issues about PHIR are still being debated within both researcher and practitioner communities. This article helps advance these debates by proposing a theoretical and methodological framework derived from ANT that makes it possible to overcome two important traditional cleavages in public health intervention research. The first is between a technicist view (intervention as a programme, a technology or a set of products) and a social view of PHI (interventions as relationships, social actors and resources, power structures, ideas and set of values) (Hawe, 2015). By proposing a sociotechnical view of interventions, ANT illuminates the process by which social actors and technical entities are linked in action networks. In such sociotechnical networks technical entities have agency in the same sense as social actors, in that they can be credited with being the source of actions.

The second cleavage is between process and effect studies of interventions, which are traditionally conducted separately using different methodologies, making it difficult to establish empirical and logical connections

between the two (Craig *et al.*, 2008). ANT helps reconcile these two types of study by supporting a research approach that employs the same conceptual repertory and methodological principles, whether it be in the identification and observation of transformations in the socio-technical network and in the intervention it supported, or in the context in which intervention is implemented. This type of approach makes it possible to capture data starting from the first significant changes in processes right through to the end results, expected or otherwise, that transform contexts.

ETHICAL APPROVAL

Ethical approval is not required because this article is a theoretical and methodological one.

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