Linking process and effects of intersectoral action on local neighbourhoods: systemic modelling based on Actor–Network Theory

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Abstract After 25 years of intersectoral practice to increase health promotion resources, there is little scientific literature linking analysis of processes to observation of effects. Applying Actor–Network Theory, this article examines how the effects of intersectoral action are produced and can be attributed to its processes. A prospective multiple case study (2013–2016) was conducted on Neighbourhood Committees (NCs) in Montreal (Canada). Three NCs were studied using four kinds of data: direct observation notes of meetings and events, documents, logbooks and interviews. Systemic modelling of local intersectoral action was used for data collection and analysis. The results show that the transformations in living environments were produced by sequences of a limited number of 'transitory outcomes' that mark the progression of intersectoral action up to its effects. The list of transitory outcomes identified make up three functions in the production of change: (i) network setup and governance; (ii) self-representing and influencing others; (iii) aligning necessary actors and resources. The production of effects follows a systemic model wherein unique configurations of transitory outcomes, adapted to the different contexts where interactions are occurring, represent the change processes that lead to the effects.

Keywords: Actor network theory, Health education/promotion, Interprofessional and interagency activity, Case studies

Introduction

It is now acknowledged that health is produced in everyday life through the transformation of locally accessible resources (Duff 2011, Krieger 2008, Macintyre 2000). The variations in quantity and quality of local resources such as housing, public services, or social networks are robustly associated with social inequalities in health (SIH) (Bernard *et al.* 2007, Macintyre *et al.* 2002). As a result, increasing the local availability and accessibility of quality resources is a key strategy to reduce SIH. Together with public policies that aim at redistributing power and resources, these two strategies cover two of the World Health Organization Commission on the Social Determinants of Health's main recommendations to address health inequality

(World Health Organization 2008). Interventions to improve the quality, availability and accessibility of these resources involve actors from various sectors, such as public, community or private organisations dealing with housing, food, transportation, education and others (Fawcett *et al.* 2010, Hunter and Perkins 2012, Moore *et al.* 2014, Poland *et al.* 2008, Potvin and Aumaître 2010). Those intersectoral partnerships may operate at various levels (local, regional, national) of public action (World Health Organization and Public Health Agency of Canada 2008). This paper provides a theoretically anchored conceptual map for understanding how local intersectoral networks produce observable transformations of locally available resources.

Although it is rooted in 25 years of practice, intersectoral action for the transformation of living environments lacks supporting scientific evidence (Asthana and Halliday 2006, McQueen and Jones 2007). The scientific literature focuses mainly on its relevance and challenges, while its structures and processes are poorly documented (Chircop *et al.* 2015, Shankardass *et al.* 2012, Villeval *et al.* 2016). A few studies highlight ranges of intermediate outcomes to be realised in order to achieve end results (Varda *et al.* 2012). Even fewer link analysis of intersectoral processes with observable effects, to shed light on effective practices (Ndumbe-Eyoh and Moffatt 2013, Varda *et al.* 2012). Leaders and researchers in the field of public health are calling for the development of theories and methods able to produce general models of change that link the processes of intersectoral interventions to the social changes to which they contribute (Chircop *et al.* 2015, Villeval *et al.* 2016).

In such models, interventions are conceived of as complex action systems that connect interventions with elements in their context. Networks underlying these interventions become the focus of the analysis (Hawe 2015, Hawe *et al.* 2009, Shiell *et al.* 2008). Studying such complex action systems requires sociological theories of public action. Notably, Actor–Network Theory (ANT) offers a relevant framework to support a network conception of intersectoral interventions (Lascoumes 1996). Three main reasons support the use of ANT to analyse complex intersectoral interventions (Bilodeau and Potvin 2018). First, ANT suggests a relational view of action, providing a means of mapping the genesis of interventions in the form of a networking process connecting social actors with material and technical entities. Second, ANT conceives of the context as being, in part, defined by the networks of actors and their actions, since social actors are constantly problematising and transforming the context in which they act through their action. Third, ANT is a powerful theoretical system for investigating how effects are produced and how they are linked to the complex process by which intervention transforms the context.

The ANT framework

Developed by Bruno Latour, Michel Callon and others since the 1980s (Latour 2005), ANT explains how actions supported by sociotechnical networks (STNs) are constructed and operated. Networks are called sociotechnical because they connect human beings with non-human entities, such as knowledge and resources (Callon 1986). These entities are connected through a continuous mediation process that makes them converge on common problematisations, negotiate shared interests, engage in new roles and mobilise a critical mass of actors for collective projects. It is by creating, reconfiguring and extending sociotechnical systems, allowing the contribution of new actors, assets and knowledge, that these networks build new solutions to meet situations that are deemed problematic. Callon and Latour (1986) call this process 'translation'. To operate and produce results, action systems must constantly be made and reconstructed, and their cohesion maintained by incentive and recruitment efforts, by movements of actors, and by instruments and practices that are capable of supporting the stabilisation, extension and durability of networks (Latour 2005).

For such systems to operate and produce changes, new roles must be negotiated and accepted by relevant entities. Commitment to new roles involves actors assuming new identities, which may lead to controversies (i.e. the confrontation between differing views that may be held by actors in a given situation, which are tied to their roles and interests) (Lascoume 2002). The process is likely to be more successful if actors identify and try to solve the controversies that impede cooperation. Solutions are developed by strengthening existing network connections, negotiating actors' new roles, and/or incorporating new relevant actors who bring new knowledge, alternative viewpoints and the resources necessary for more convergent solutions (Callon 1986, Latour 2005).

Such action systems need legitimate and credible spokespersons to represent them and speak on their behalf. The legitimacy of such spokespersons is based on the positions they occupy, which grant them recognition by others. Their credibility depends on the value that others place on the information they convey. The spokespersons assemble various entities, known as intermediaries, which contribute to their representations. These intermediaries represent concrete material (figures, briefs) that conveys ideas and positions without transforming them. They stabilise agreement within a network and help communicate its positions to other actors of interest or to networks (Callon 1991).

Using ANT to frame the study of intersectoral action, this article examines two current critical questions: How does intersectoral action work? How are the observed effects produced, and can they be attributed to intersectoral action?

Montreal NCs

In Montreal, local intersectoral action is organised through 30 NCs supported by the *Montreal initiative for local social development* (MI) (Comité de pilotage de l'Initiative montréalaise de soutien au développement social local 2015). The MI, which has been operating since 1997, combines three regional funding agencies (Centraide of Greater Montreal, the City of Montreal and the Montreal Directorate of Public Health) and the Montreal NC Coalition, which represents the 30 NCs.

Neighbourhood Committees are permanent mechanisms that bring together the main public, community, political and private actors of a neighbourhood, as well as citizens. Starting with a neighbourhood profile and a participatory diagnostic process, they build a common vision of the neighbourhood's urban, social and environmental issues. They define local priorities, establish an action plan and initiate or coordinate projects to transform living environments. These NCs represent spaces wherein actors of various backgrounds, interests and expertise can converge. They help boost citizen participation, strengthen networks, advocate for progressive public policies and enhance community life (Sénécal *et al.* 2010). Their actions have a real impact on neighbourhood dynamics, notably through the adoption of collective action plans and urban revitalisation efforts (Cloutier *et al.* 2010).

As instances of local intersectoral action, NCs were studied using the following research questions: (i) What health-promoting transformations in living environments result from their intersectoral action? (ii) What characterises their actions? (iii) What are the links between processes (committee actions) and effects (transformations)?

Methods

The study design was based on three ANT-derived methodological guidelines (Bilodeau and Potvin 2018): (i) Develop a data entry system that follows and documents transformations in the STN, its action, effects and context, and how the actors themselves define what is going

on; (ii) Adopt a chronological ordering of events, as ANT focuses on processes, which evolve over time; (iii) Use a broad range of data to capture the complex ways in which the intervention and its supporting network evolve.

A prospective 4-year multiple case study was conducted from January 2013 to December 2016. A longitudinal follow-up was carried out with continuous data collection. The cases were six action systems nested within three volunteer NCs. The two action systems selected within each participating NC consisted of: (i) its central action system for coordination, that is, its governance and operations, with its subcommittees and its partners; and (ii) the action system of a specific project derived from the local action plan underway at the time of the study and active for at least 2 years prior to the study. An integrated knowledge exchange partnership was established with actors of MI and with the three NCs under study (Graham *et al.* 2006). Formal ethical approval was obtained from the Health Research Ethics Committee of the University of Montreal (#14-117 CERES-D) and from the Research Ethics Committee of the Montreal Directorate of Public Health (#288).

Model of data collection
Systemic modelling (Le Moigne 1994, 1999) based on the concepts of ANT was the methodology used to organise the data coding system and reconstruct the evolution of the action systems under study. Our modelling tool connects the STN, the translation process and the system purposes, within its context and over time. System purposes are the overarching goals of the action systems. Context is the dynamic system in which the intervention takes place, shaped by the location with its resources and constraints, populations, ongoing activities, organisations and institutions, the actors, the connections and interactions among these entities (Hawe *et al.* 2009, Pfadenhauer *et al.* 2016). This also involves issues that mobilise the NCs as well as the transformations of the environment arising from their work in different areas of local social development. Three matrices were created to code the STN, the translation operations within the system, and the controversies among actors respectively.

The STN is the organisation of relationships between all active entities of the action system. These are heterogeneous human entities (actors from public, community, political or private sectors, and citizens) and non-human entities (specialised knowledge, material and financial resources, laws and public policies, programmes, reports, etc.). The sociotechnical matrix included five main concepts used to organise data about each entity composing the network: *connection to the situation* – what connects the entity to the STN; *social position* – the entity's position in social stratification; *identity and roles* – the entity's relationship to the action; *interests and issues* – the rationale underlying the entity's involvement in the action and what is at stake; and *power relations* – capacity to influence other actors' behaviour and position within the system.

The translation process is constituted by the interactions, mediations and actions that connect entities within the network. The translation operation matrix includes four main concepts: *problematisation* – the actual and potential links between entities, their identity and interest with regard to the action; *interestment* – strategies, devices and negotiations that are used to recruit new entities and strengthen existing connections; *enrolment* – how actors are displaced and their interests aligned; and *mobilisation* – stability of the network connexions, solidity of spokespersons, engagement of a critical mass of connected actors to develop a sustainable capacity to act.

The controversy matrix is used to unravel and inventory the tangled arguments in a controversy and link them to involve actors' identities and interests. Three main concepts distinguish arguments relating *scientific knowledge* (objective world), *experiential knowledge* (subjective world) and *values* (normative world).

Finally, the timeline leads to follow transformations in the network, the translation process and controversies over time.

Four types of data were collected to populate these matrices: (i) direct observation notes taken during meetings of committees and other relevant events; (ii) documents such as minutes from relevant committee meetings, administrative documents (neighbourhood profiles, action plans and reports), media (NC newsletters, websites and Facebook feeds of organisations, press releases, local newspapers) and ephemera (emails, meeting agenda); (iii) structured logbooks completed by the NC coordinators (in writing or through telephone interviews with a research assistant) to collect information about action that took place outside the observed meetings and (iv) interviews with the coordinators for complementary data and for research follow-up and validation of preliminary analyses. Table 1 lists all collected data.

Analysis

The analysis took place in four steps. (i) Ethnographies of the two action systems in each participating NC were produced, describing the events (actions) that transformed the action systems and their context, over time, up until effects in living environments were observed. Each ethnography was validated with the appropriate NC. (ii) Using a pilot case, one local ethnography was analysed using ANT concepts, leading to identification of the critical events in the progression towards the effects and the naming of these events in generic terms referring to ANT concepts. We used the term 'transitional outcomes' (TO) to designate these critical events that mark the progression of the action towards its effects in the form of observable

Table 1 *List of data compiled from January 2013 to December 2016 in each of the three participating NCs under study*

Data sources	NC 1		NC 2		NC 3	
	C	P	C	P	C	P
Direct observation notes						
Number of Coordination and Project committee meetings observed/held	17/50	12/34	11/18	24/36	21/26	15/19
Number of meetings of other committees	–	–	–	3	–	16
Number of events	–	–	–	13	–	12
Number of documents, media, ephemera						
Coordination/project committees	205	275	294	144	98	153
Other committees and events	–	–	303	117	–	406
Logbook						
Number of phone exchanges (time)	8 (8 h15)	11 (6 h15)	–	3 (3 h45)	17 (19 h)	
Number of written pages	–	15	–	24	–	
Interviews (3 hours each)	19		13		14	

NC, Neighbourhood Committee; C, coordination; P, specific project.

transformations in the physical or social local environment. (iii) A model of the chain of critical events – and the corresponding TO – leading to the effects was developed for each of the six action systems, then validated with the actors. (iv) A cross-case analysis of these models was conducted to stabilise the list of TO, which was subsequently validated within the research partnership.

Results

Results are presented in two main sections. First, the three cases are presented highlighting the critical events of intersectoral processes that marked the progress of the action. These events are interpreted as TO and are labelled using ANT-related concepts. Secondly, the resulting 12 TO are defined in theoretical terms related to ANT, and properties of the systemic modelling of TO chains are presented.

Intersectoral processes and TO leading to local transformations
Case 1 Neighbourhood 1 is a sparsely populated suburban area (49,070 inhabitants). It includes an extensive industrial zone and is crisscrossed by major urban boulevards and a regional expressway. Its historical industrial background has led to the establishment of a low-skilled and undereducated middle class. Poverty (affecting 17% of the population compared to an overall average of 23% for Montreal[1]) is concentrated in three isolated areas. There is a shortage of local services, difficult access to specialised training or to healthy food, while services are principally located on the main streets and public transit is unsuitable for local travel. The NC had been working since 2008 to shift from a targeted-population approach to an integrated territorial approach (ITA) to poverty. This shift was central to the 2012–2017 work plan that includes priorities related to impoverishment, employment, transportation and land-use planning. In this case, our results focus on the central action system, which best illustrates the governance process that had to deal with the controversy around the transition towards an ITA.

Collective action took place from 2010 to 2016 at the neighbourhood level with interactions with regional actors such as funders. In *2010*, the NC applied to, and received, seed funding from Centraide (*TO: Resource capturing*) and set up a Living Conditions Committee (LCC) (*TO: Network creation*) with a view to implementing the shift towards the ITA. In *Spring 2011*, the LCC produced a neighbourhood diagnosis report conveying information about the three poorest areas in the neighbourhood (*TO: Production of intermediaries*). *During 2013*, this report was discussed with local citizens in a series of *World Cafés* and was further expanded by incorporating results from this process (*TO: Strengthening of spokespersons and intermediaries*). A synthesis of the *World Café* discussions identifying priorities (*TO: Production of intermediaries*) was presented to the borough's elected officials with the aim of bringing the citizens' perspectives to their attention and ultimately influencing them (*TO: Placement of intermediaries*). Also *during 2012–2013*, the NC presented its ITA plan to the local sectoral committees (i.e. those responsible for the targeted-population approach), who did not show much interest for the ITA at that time. However, in *Spring 2014*, a funding programme targeting the social determinants of youth health took a stand in favour of ITA and transferred the programme's local leadership to the NC (*TO: Strengthening of spokespersons and intermediaries*), whereas the associated funding was redirected to the LCC (*TO: Resource capturing*). *During 2014 and 2015*, the NC enrolled two agencies to support the local shift towards ITA (*TO: Network expansion and strengthening*). In *November 2015*, a regional consortium of philanthropic funders launched a new funding programme called Collective Impact Projects (CIP)

to support integrated neighbourhood (IN) work plans. In *Spring 2016*, this consortium awarded funding to NC to continue the development of its IN work plan (*TO: Resource capturing*). At the same time, committees that work with a targeted-population approach started to question their capacity to maintain their mission and activities (*TO: Actor movement*). *During 2016–2017*, while significant additional funding from the CIP was at stake, work from all parties on the integrated plan led to completing the shift towards ITA (*TO: Resolution of controversies*). Concomitantly, the LCC cashed in small gains such as the elected officials support of the citizen needs expressed during the *World Cafés* (*TO: Actor movement*) namely, the need for elderly people to have park benches installed on the way to grocery stores, to help them do grocery shopping on foot. The installation of these park benches constitutes observable transformation of the neighbourhood environment.

Case 2 Neighbourhood 2 is a district of 45,000 inhabitants, among whom 36 per cent live below the low-income cut-off. This territory with a blue-collar and industrial past was hard hit by the recession of the early 1980s that left many vacant lots and an impoverished population. In 2008, local actors undertook a broad discussion on collaborative ties among multisectoral stakeholders, as in case 1, considering the value of a shift from a targeted-population approach to an ITA to poverty. This shift was central to their 2010–2015 action plan. In this case, we followed this central coordinating committee, whose actions led to the following concrete transformations in living environment: (i) animated sports facilities (slides, ice circuit, winter carnival, sports leagues); (ii) social resources in the form of 'sentinels', e.g. young people who ensure the safety of students on their way to and from school by keeping away drug dealers; (iii) urban agriculture in the common area of a low-cost housing facility, which includes gardens and vegetable production, gardening workshops provided by teens to toddlers, cookery workshops, beautification, re-appropriation and animation of the collective space.

The collective action conducive to these transformations took place from 2010 to 2015, mainly at the neighbourhood level. In *June 2010*, the process began with setting up a Joint-action Committee (JC) mandated to provide a mapping of the local committees involved in collective action and to propose models to implement an ITA (*TO: Network creation*). The JC produced a context-adapted model of ITA (*TO: Production of intermediaries*) that was presented at the NC meeting of *November 2011* (*TO: Placement of intermediaries*). This led to the redefinition, in *June 2012*, of the NC's membership and Board of Directors to include institutional and private sectors as well as citizens, in addition to community organisations (*TO: Adoption of network governance structures and rules*). In *April 2013*, a structuration plan was adopted by the NC (*TO: Activation of intermediaries*). Following lengthy debates and compromises (*TO: Actor movement*), the identification of six overarching issues led to the creation of six JCs (Physical activity, leisure and culture; Food; Land-use planning; Advocacy; Education; and Health) connected though a Spokesperson Committee representing each of the six committees (*TO: Network creation*).

In *Fall 2013*, the collective work of neighbourhood planning for all started. In *October 2014* funders, whose mandates were segmented by age groups (0–5, 6–11, 12–17 years old) and themes (e.g. literacy, physical activity), agreed to harmonise their submission schedules with the integrated planning calendar of local actors (*TO: Actor movement*). Furthermore, one funder transferred the local coordination of two funding programmes to the NC, strengthening the integrated planning (*TO: Strengthening of spokespersons and intermediaries*). A 6-day workshop was convened to produce the plan, notably to integrate the segmented funds. The NC and the Spokesperson Committee supported the flow of ideas between committees by making many representations (*TO: Representation by spokespersons*). In *February 2015*, an outline (priorities, action strategies) of the Youth Plan (0–17 years old) was established (*TO:*

Production of intermediaries) and a call for joint projects was launched among all the NC actors. The Education, Food and Physical activity Committees collaborated to define their contribution and mobilised many actors for joint projects (*TO: Network expansion and strengthening*). In *April 2015*, the NC selected joint projects for the Youth Plan that were submitted to funders (*TO: Placement of intermediaries*) and financed (*TO: Resource capturing*). Implementation followed during *2015–2018*, leading to the above-mentioned observable transformations.

Case 3 Neighbourhood 3 operates in a central borough of 30,000 inhabitants, of whom 38 per cent live under the low-income cut-off. Industrial facilities and major institutional lots leave little place for vegetation. The neighbourhood is affected by social problems characteristic of urban centres – homelessness, mental disorders, addiction – and it faces problems of security and of access to safe housing, affordable healthy food, and green spaces. Since 2008, the NC has been the mechanism for coordinating all the community, public and private actors involved in social development of the neighbourhood. Its 2011–2014 action plan focussed on safety of local commuting, greening, animated public places and food supply. In this case we present the specific project Green and Safe Neighbourhood (GSN), which evolved into Integrated Neighbourhood (IN), then into Nurturing Neighbourhood (NN), as different funding opportunities came along. The effective transformations it produced included redevelopment of a community food market – refrigeration equipment, educational and cultural programming, extended opening hours – and installation of a community greenhouse – production, transformation, distribution of produce at low cost; collective kitchens; workshops on urban agriculture and environment; jobs and occupational internships for at-risk youth.

The collective action leading to these transformations took place from Spring 2012 to Winter 2016 at the neighbourhood and city levels. A Green and Safe Neighbourhood Committee (GSNC) was created (*TO: Network creation*) and began its work by producing a brief on issues of security and greening within the neighbourhood (*TO: Production of intermediaries*). The GSNC presented this brief to the Borough Council, which recommended it to the City Council and to government officials (*TO: Placement of intermediaries*). In *May 2013*, the city created a new programme, IN, for which the borough was a pilot site. An Integrated Neighbourhood Committee (INC) was formed (*TO: Network creation*) and, in *September 2013*, the GSNC's brief served as a basis for the IN process (*TO: Activation of intermediaries*). Other neighbourhood actors got involved in the INC (*TO: Network expansion and strengthening*), notably two organisations active in urban agriculture and landscaping that would proceed to take on a central role (*TO: Actor movement*). In *October 2013*, the INC submitted an IN brief to the borough (*TO: Placement of intermediaries*) as a means to disseminate the community's perspective and influence the borough and the city. In *March 2014*, the borough approached the INC to register for the city's programme Imagine-Realise-Montreal-2025 (IRM-2025), a testimony to the credibility gained by its briefs, which were circulating within the administration (*TO: Strengthening of spokespersons and intermediaries*). A consensus was reached in the INC about redeveloping the community food market located on the site of the local subway station and the creation of a community greenhouse on a site to be determined. The project was approved by the city council and gained support from the borough, notably through streamlining the regulatory and construction process for the greenhouse (*TO: Actor movement*). In *Winter 2015*, the project, named NN, pursued food security, greening, revitalisation of a public place, occupational training and placement in horticulture, and education on urban agriculture.

In *Spring 2015*, the NN partners involved new actors and collaborated to submit a funding request to the city's programme Neighbourhood 21-IN, targeting support of young people in occupational training at the greenhouse (*TO: Network expansion and strengthening*). The

borough committed to take responsibility for the building of the greenhouse and committed to buying its flower production for annual distribution to residents (*TO: Commitment of decision makers to achieving change*). This support ensured the city's approval and funding of the occupational training project and, in *June 2015*, the NN project submitted to IRM-2025 was also funded by the city (*TO: Resource capturing*). In *November 2015*, the market received the permit for the water and electrical connections (*TO: Commitment of decision makers to achieving change*), and in *Winter 2016* the borough signed an agreement with a private company to formalise use of the land where the greenhouse would be built (*TO: Commitment of decision makers to achieving change*). The NN partners continued their work building consensus among members and citizens with respect to the project and other activities carried out in the territory.

A limited number of TO punctuates the progression of local intersectoral action until its effects in living environments
As shown across the three cases, linking ANT concepts with empirical data led to identifying a list of 12 TO that represent the progression of action systems towards producing observable changes in living environments. Each TO can include various events. These TOs contribute to three functions of networks in the production of change: (i) network setup and governance; (ii) self-representing and influencing others; (iii) aligning necessary actors and resources.

Network setup and governance refers to the formation and governance of networks and to the resolution of controversies. Three TOs contribute to this function:

• Network creation: Establishing linkages between heterogeneous social actors and non-human entities (knowledge, reports, policies, technologies, funding), including setting them into motion and committing them to negotiate roles as part of collective action to achieve the network's ends.
• Adoption of network governance structures and rules: The organisation of collective work that is adopted and applied by a network. These concern the tools and practices that regulate the participation of the concerned parties, the legitimacy of their spokespersons and the collective decision-making process.
• Resolution of controversies: Identifying and elaborating solutions in the case of controversies that prevent actors from cooperating. This is achieved by reconfiguring the network – moving actors, adding relevant actors who bring new knowledge and resources, strengthening certain bonds and dissolving others (removing certain actors) – and by developing new, more durable solutions that enable cooperation.

Self-representing and influencing others refers to actions and productions of networks to communicate, influence and reach a critical mass of actors around a purpose. Five TOs contribute to this function:

• Production of intermediaries: Setting convergent ideas and positions (priorities, projects) into material form (plans, briefs) within a network. These intermediaries stabilise agreement and convey the ideas and positions to other actors of interest or to networks, in order to achieve the network's ends.
• Placement of intermediaries: Introducing intermediaries into other networks, to decision makers, to media, or within other intermediaries, where they can be adopted/adapted to move towards achieving the desired ends.
• Activation of intermediaries: Promotion and use of intermediaries by actors of interest or networks who have received them.

- Representation by spokespersons: Statements to communicate positions, generate interest, influence the position or commitment of other actors of interest or networks to achieve the network's ends.
- Strengthening of spokespersons and intermediaries: Reinforcing the legitimacy and credibility of spokespersons and of the intermediaries they convey, ensuring that they are better recognised by the populations and groups on whose behalf they speak and taken into greater consideration by strategic actors. Various activities can help achieve this, e.g. participation in public consultations, representation at various forums. There are various signs of successful recognition, e.g. invitations to speak at important forums, recognition by funding organisations.

Aligning necessary actors and resources refers to essential movements among the actors for the achievement of objectives. Four TOs contribute to this function:

- Actor movement: Changes in positions (opinions, points of view), actors' engagement in new roles, transformations of power relationships in ways that promote collective action and achievement of the networks' ends. These movements arise out of negotiations and power plays among the actors.
- Resource capturing: harnessing the resources necessary for the network's operation and to achieve its ends, namely: funding, labour, technical support, logistics and expertise.
- Network expansion and strengthening: Recruiting new actors, adding non-human entities, strengthening ties within a network or between networks.
- Commitment of decision makers to achieving change: Commitment of actors holding the reins of decision making and action, whether inside or outside a network (e. g., municipal services, businesses, non-profits, community organisations), to realising effective transformation of living environments.

Chains of TO link processes to effects

Modelling the chains of TO that lead to producing effects in each of the six action systems links the processes to observable effects. The models also highlight the dynamic interaction between the action system and its context. The critical events – represented by the TOs – that make up the processes of change in different contexts are built from elements of the context, which are connected and activated in a singular way by the STNs, so as to move towards change. The 12 generic TOs identified can represent a variety of events and a variety of sequences of critical events can produce observable changes specific to each context. Thus, the production of effects by local intersectoral action follows a systemic model wherein the sequences consist in unique configurations of TOs leading to effects, according to contexts. The sequence of TOs can be interrupted or abandoned, be taken up again by other networks of actors, or include a few iterations of the same TOs. Modelling the trajectory of TOs is a means to capture the dynamic process that leads to effective transformations, as variable and unpredictable as this process can be.

Discussion

Since the early 2000s, researchers have been grappling with the concept of complexity to characterise population health interventions (Petticrew 2011). Some consider an intervention as a string of significant events that occur in time, within an existing system, transforming it (Hawe *et al.* 2009). Such an approach helps to understand the many interactions between the context,

actors and their actions, and to consider the intentionality of the action, as well as the variability and unpredictability of results (Medical Research Council 2008). To date, the scientific literature has mainly discussed ontological and epistemological issues related to this complexity (Frerichs *et al.* 2016, Hawe 2015, Hawe and Potvin 2009, Hawe *et al.* 2009, Lacouture *et al.* 2015, Moore *et al.* 2014, Shoveller *et al.* 2016), including theories and methods (Bilodeau and Potvin 2018, Datta and Petticrew 2013, Dupin *et al.* 2015, Shiell *et al.* 2008) suitable to studying complex interventions. However, the literature offers few applications of this conception or of the scientific knowledge it can produce (Orton *et al.* 2017). Our results contribute in a practical way to opening up the black box of complex interventions. They explain what happens in the interaction between the networks of actors, the actions they undertake, and the context in which they act, as well as how effects are produced.

Modelling local intersectoral action, which links the process to the effects, shows that a limited number of TO punctuate the progression of action until its effects are realised. Three essential functions of networks in the production of change emerge from the TOs: setup and governance; self-representing and influencing others; and aligning the actors and resources necessary for the action. The generic 12 TOs and the three associated functions represent a theory of the generative process of change by which local intersectoral action produces effects. The production of effects follows a systemic model wherein unique sequences of TOs, adapted to the different contexts in which interactions occur, represent the change processes that lead to the effects.

A first focal point of researching complex interventions is explaining and theorising the *how* of an intervention, that is, the process by which the intervention operates and produces its effects (Dupin *et al.* 2015). In reference to Hawe Hawe *et al.* (2009), who conceive of an intervention as events within existing systems, our inventory of 12 TOs conceptualises these critical events in terms of local intersectoral action. Modelling using the TOs traces the chain of critical events up to the effects of the intervention.

A second focal point is promoting understanding of intervention–context interactions. Our results shed light on this issue in two ways. First, they show how the context provides ingredients (Dupin *et al.* 2015) for intervention. Actors mobilise around a situation deemed problematic within the context. Their representation of the problem situation depends on the entities that make up this situation and on how these entities are related. Consistent with the findings of Orton *et al.* (2017), our results show that the STN builds the intervention by connecting human and non-human entities mobilised in the context, giving the intervention its local colour. In our results, the TOs that make up the action are spaces for intervention–context interaction. The TOs related to setting up and maintaining networks, as well as those relating to the alignment of actors and resources, are produced from entities that are available from the context. The TOs relating to self-representation and influence are only produced in the face of relevant actors for whose sake representation and influence are required. The unique trajectories of TOs illustrate this basis of the intervention in its context. Second, our results empirically demonstrate the notion that context is a dynamic system in which the intervention takes place, in order to transform it (Hawe 2015, Hawe *et al.* 2009). The modelling of chains of TOs shows that human and non-human entities, engaged in an action network, in a context at a given time, were already interacting in a pre-existing action system. The intervention fits into, and is constructed from, elements of this system. It modifies the system where it takes place by causing a shift in action networks and by transforming resources. The modelling of the process of production of effects empirically illustrates how networks are recomposed from what already exists, and what transformations they affect in living environments.

Finally, a third point of focus is the use of general theories that link processes to intervention effects (Chircop *et al.* 2015). The 12 generic TOs and systemic modelling they produce, constitute a mid-range theory of the process by which local intersectoral action produces effects on living

environments. This mid-range theory emerged from our data because our analysis was based on ANT, a general social theory that can grasp the complexity of social change processes such as the ones studied here (Bilodeau and Potvin 2018). Sociotechnical networks form, act and transform gradually as they develop an intervention, within a context and over time, until effective transformations are achieved. The 12 generic TOs we derived from ANT describe this process. ANT notions offer new insights on the processes of local intersectoral action. For instance they highlight the linking of heterogeneous universes and the agency of non-human entities in action networks (TO Network creation). They point to the critical role of controversies in shaping collective action (TO Resolution of controversies), the role of intermediaries (TOs Production, Placement and Activation of intermediaries), the importance of actor enrolment in new positions to achieve alignment of interest (TO Actor movement) and the need to mobilise a critical mass of connected actors (TO Network expansion and strengthening).

Limitations

This research focuses on local intersectoral action and considers the role and importance of higher governance levels (e.g. public policies, funding programmes) only to the extent that local actions were directly related to them by local actors. This relates to the methodological rules of the research, derived from ANT, that is, to follow the action wherever it unfolds. However, this limit the ability of research to illuminate the cross-level process of public action. Another limitation is the limited number of cases under study. These results would benefit from further validation in more extensive studies.

Conclusion

Interventions on social determinants of health through local intersectoral action can lead to concrete transformations in living environments. These transformations correspond to the local needs, culture and history of local communities, as reflected in the NCs' action and results. As these transformations, even modest, add up and combine, they render living environments more salutogenic (Bernard *et al.* 2007).

Local intersectoral networks, such as the NCs, support these transformations by producing chains of TO that mark the progression of an action up to its effects. It is necessary to make local intersectoral action more effective by laying out its action mechanisms, as this is critical to developing strategies to address many collective issues in population health. This knowledge is immediately useful to practitioners and managers who need to justify the use of intersectoral action for creating health-promoting resources in living environments. These results can serve as a starting point for additional research to: (i) validate the modelling produced here with a larger number and wider variety of cases; (ii) identify regularities within chains of TO that are associated with observable effects or, conversely, that characterise ineffective chains.

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Note

1 Due to the methodological changes made by Statistics Canada, 2011 Census data should be interpreted with caution.

References

Asthana, S. and Halliday, J. (2006) Developing an evidence base for policies and interventions to address health inequalities: the analysis of 'public health regimes', *Milbank Quarterly*, 84, 3, 577–603.

Bernard, P., Charafeddine, R., Frohlich, K.L., Daniel, M., *et al.* (2007) Health inequalities and place: a theoretical conception of neighbourhood, *Social Science and Medicine*, 65, 9, 1839–52.

Bilodeau, A. and Potvin, L. (2018) Unpacking complexity in public health interventions with actor-network theory, *Health Promotion International*, 33, 1, 173–81.

Callon, M. (1986) Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieux Bay. In Law, J. (ed.) *Power, Action and Belief: A New Sociology of Knowledge?* London and Boston: Routledge & Kegan Paul.

Callon, M. (1991) Techno-economic networks and irreversibility. In Law, J. (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*. London and New York: Routledge.

Callon, M. and Latour, B. (1986) Les paradoxes de la modernité. Comment concevoir les innovations? *Perspective et Santé*, 36, 13–25.

Chircop, A., Bassett, R. and Tatlor, E. (2015) Evidence on how to practice intersectoral collaboration for health equity: a scoping review, *Critical Public Health*, 25, 2, 178–91.

Cloutier, G., Méthé-Myrand, L. and Sénécal, G. (2010) La revitalisation urbaine intégrée et la plus-value de l'approche montréalaise: une comparaison, *Canadian Journal of Urban Research*, 19, 1, 23–49.

Comité de pilotage de l'Initiative montréalaise de soutien au développement social local. (2015) *Cadre de référence Initiative montréalaise de soutien au développement social local. Des quartiers où il fait bon vivre*. Montréal: Comité de pilotage de l'Initiative montréalaise de soutien au développement social local.

Datta, J. and Petticrew, M. (2013) Challenges to evaluating complex interventions: a content analysis of published papers, *BMC Public Health*, 13, 568.

Duff, C. (2011) Networks, resources and agencies: on the character and production of enabling places, *Health & Place*, 17, 149–56.

Dupin, C.M., Breton, E., Kivits, J. and Minary, L. (2015) Pistes de réflexion pour l'évaluation et le financement des interventions complexes en santé publique, *Santé Publique*, 28, 5, 653–7.

Fawcett, S., Schultz, J., Watson-Thompson, J., Fox, M., *et al.* (2010) Building multisectoral partnerships for population health and health equity, *Preventing Chronic Disease*, 7, 6, 1–7.

Frerichs, L., Lich, K.H., Dave, G. and Corbie-Smith, G. (2016) Integrating systems science and community-based participatory research to achieve health equity, *American Journal of Public Health*, 106, 2, 215–22.

Graham, I.D., Logan, J., Harrison, M.B., Strauss, S.E., *et al.* (2006) Lost in knowledge translation: time for a map?, *The Journal of Continuing Education in the Health Professions*, 26, 13–24.

Hawe, P. (2015) Lessons from complex interventions to improve health, *Annual Review of Public Health*, 36, 307–23.

Hawe, P. and Potvin, L. (2009) What is population health intervention research?, *Canadian Journal of Public Health*, 100, 1, 1–14.

Hawe, P., Shiell, A. and Riley, T. (2009) Theorising interventions as events in systems, *American Journal of Community Psychology*, 43, 267–76.

Hunter, D. and Perkins, N. (2012) Partnership working in public health: the implications for governance of a systems approach, *Journal of Health Services Research & Policy*, 17, Suppl 2, 45–52.

Krieger, N. (2008) Proximal, distal, and the politics of causation: what's level got to do with it?, *American Journal of Public Health*, 98, 2, 221–30.

Lacouture, A., Breton, E., Guichard, A. and Ridde, V. (2015) The concept of mechanism from a realist approach: a scoping review to facilitate its operationalization in public health program evaluation, *Implementation Science*, 10, 153.

Lascoume, P. (2002) Chapitre 7. De l'utilité des controverses sociotechniques, *Journal International de Bioéthique*, 3, 68–79.

Lascoumes, P. (1996) Rendre gouvernable: de la 'traduction' au 'transcodage'. L'analyse des processus de changement dans les réseaux d'action publique. In CURAPP (ed.) *La gouvernabilité*. Paris: Presses universitaires de France.

Latour, B. (2005) *Reassembling the Social. An Introduction to Actor–Network-Theory*. New York: Oxford University Press.

Le Moigne, J.L. (1994) *La théorie du système général: Théorie de la modélisation*. Paris: PUF.

Le Moigne, J.L. (1999) *La modélisation des systèmes complexes*. Paris: Dunod.

Macintyre, S. (2000) The social patterning of exercise behaviours: the role of personal and local resources, *British Journal of Sports Medicine*, 34, 1, 6.

Macintyre, S., Ellaway, A. and Cummins, S. (2002) Place effects on health: how can we conceptualise, operationalise and measure them?, *Social Science & Medicine*, 55, 1, 125–39.

McQueen, D.V. and Jones, C.M. (2007) *Global Perspectives on Health Promotion Effectiveness*. New York: Springer.

Medical Research Council. (2008) *Developing and Evaluating Complex Interventions: New Guidance*. London: MRC.

Moore, G., Audrey, S., Barker, M., Bond, L., *et al.* (2014) Process evaluation in complex public health intervention studies: the need for guidance, *Journal of Epidemiology and Community Health*, 68, 2, 101–2.

Ndumbe-Eyoh, S. and Moffatt, H. (2013) Intersectoral action for health equity: a rapid systematic review, *BMC Public Health*, 13, 1056.

Orton, L., Halliday, E., Collins, M., Egan, M., *et al.* (2017) Putting context centre stage: evidence from a systems evaluation of an area based empowerment initiative in England, *Critical Public Health*, 27, 4, 477–89.

Petticrew, M. (2011) When are complex interventions complex? When are simple interventions simple?, *European Journal of Public Health*, 21, 4, 397–9.

Pfadenhauer, L., Rohwer, A., Burns, J., Booth, A., *et al.* (2016) Guidance for the assessment of context and implementation in health technology assessment and systematic reviews of complex interventions: the context and implementation of complex interventions (CICI) framework. Available at http://www.integrate-hta.eu/downloads/ (Last accessed 14 May 2018).

Poland, B., Frohlich, K.L. and Cargo, M. (2008) Context as fundamental dimension of health promotion program evaluation. In Potvin, L. and McQueen, D. (eds) *Health Promotion Evaluation Practices in the Americas. Values and Research*. New York: Springer.

Potvin, L. and Aumaître, F. (2010) Les partenariats: espaces négociés de controverses et d'innovations. In Potvin, L., Moquet, M.J. and Jones, C.M. (eds) *Réduire les inégalités sociales en santé*. Saint-Denis: Institut national de prévention et d'éducation pour la santé.

Sénécal, G., Cloutier, G., Méthé-Myrand, L. and Dubé, A. (2010) Les grands projets résidentiels au défi de la concertation de quartier. Le cas des Tables de quartier à Montréal, *Annales de la Recherche Urbaine*, 106, 70–9.

Shankardass, K., Solar, O., Murphy, K., Greaves, L., *et al.* (2012) A scoping review of intersectoral action for health equity involving governments, *International Journal of Public Health*, 57, 25–33.

Shiell, A., Hawe, P. and Gold, L. (2008) Complex interventions or complex systems? Implications for health economic evaluation, *British Medical Journal*, 336, 1281–3.

Shoveller, J., Viehbeck, S., Di Ruggiero, E., Greyson, D., *et al.* (2016) A critical examination of representations of context within research on population health interventions, *Critical Public Health*, 26, 5, 487–500.

Varda, D., Shoup, J.A. and Miller, S. (2012) A systematic review of collaboration and network research in the public affairs literature: implications for public health practice and research, *American Journal of Public Health*, 102, 3, 564–71.

Villeval, M., Bidault, E., Shoveller, J., Alias, F., *et al.* (2016) Enabling the transferability of complex interventions: exploring the combination of an intervention's key functions and implementation, *International Journal of Public Health*, 61, 1031–8.

World Health Organization. (2008) *Closing the Gap in a Generation. Health Equity through Action on the Social Determinants of Health*. Geneva: World Health Organization.

World Health Organization and Public Health Agency of Canada. (2008) *Health Equity through Intersectoral Action: An Analysis of 18 Country Case Studies*. Ottawa: Public Health Agency of Canada.