Human Relations
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Human Relations 2004; 57; 597
DOI: 10.1177/0018726704044311

Human Relations
DOI: 10.1177/0018726704044311
Volume 57(5): 597–618
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SAGE Publications
London, Thousand Oaks CA,
New Delhi
www.sagepublications.com

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Chris Goldspink and Robert Kay

ABSTRACT

A 'pervasive' problem in the social sciences, referred to as the 'micro-to-macro problem' concerns our capacity to explain the relationship between the constitutive elements of social systems (people) and emergent phenomena resulting from their interaction (i.e. organizations, societies, economies). Without a capacity to explain this relationship there is, in effect, no substantive theory of sociality. In this article, we explore the potential of a synthesis between autopoietic and complexity theory for understanding social systems in a way that addresses this issue. It is argued that autopoietic theory provides a basis for understanding the characteristics of the micro-level agents that make up social systems – human individuals, whereas complexity theory provides a basis for understanding how these characteristics influence the range and type of macro-level phenomena that arise from their interaction. The synthesis proposed here provides the basis for a theory of sociality that deals consistently with the relationship between the micro- and macro-levels of social phenomena and their ontological status. This approach has the potential to re-unite current scientific oppositions and avoid unnecessary pluralism within social science.

KEYWORDS

autopoiesis ▪ complexity theory ▪ critical realism ▪ social science ▪ social systems ▪ sociology

Introduction

In this article we draw attention to a commonly overlooked yet 'pervasive' problem in the social sciences. It is most regularly referred to as the 'micro-to-macro problem' (Coleman, 1994; Smith, 1997) and concerns the capacity for theory to explain the relationship between the constitutive elements of social systems (people) and the emergent phenomena that result from their interaction (i.e. organizations, societies, economies). Without the capacity to explain this relationship we would argue that there is, in effect, no substantive theory of sociality. The term social is used here to refer to patterns of interaction which take place and persist in time between at least two agents of the same class (species) – in this case – humans.

What is the basis of the micro–macro divide?

The micro–macro problem may be seen to emerge from attempts to resolve two fundamental questions in social science.

1. Ontologically, what is the origin or nature of social phenomena and how do they emerge from the actions of individuals in particular contexts of action?
2. Epistemologically, how is it that we can come to know about social phenomena?

Both questions are complicated by the fact that many, if not all, of the contexts of action are themselves social, and the act of observation is itself a part of the phenomena being observed and therefore needs to be explained (Bhaskar, 1997; Lincoln & Guba, 1985).

Critical realists argue convincingly that previous attempts to answer these questions have suffered from an inappropriate 'bundling' of epistemic and ontological assumptions (Archer, 1998; Bhaskar, 1998). Typically, realism is bundled with objectivism and idealism is bundled with relativism. This has led to a dichotomous tendency within social science (modernism versus post-modernism, naturalism versus anti-naturalism) and a resultant plethora of perspectives and their associated assumptions (Burrell & Morgan, 1994). Each offers a valuable perspective but is partial in scope and coverage. Attempts to cover the whole range of phenomena cannot be attained within one position and straddling positions invokes conflicting assumptions.

By teasing these bundles apart an alternative position is possible.

Critical realists argue that an appropriate orientation for social theory is to be found by adopting realist ontology and a relativist epistemology. This is the position we have come to as a result of theoretical analysis undertaken in order to find a consistent basis for our lived experience in organizations.

One of the implications of this approach is the need to distinguish between observable phenomena or patterns and the causal laws that generate them. Furthermore, the distinction of pattern constitutes an act of observation by a particular observer. There is a need, therefore, for adequate social theory to distinguish clearly between three layers of reality: '. . . empirical (observable by humans), actual (existing in time and space), and real (transfactual and more enduring than our perception of it)' (Kaboub, n.d.). We argue that such a theory can be arrived at by a synthesis of two existing areas of inquiry – Maturana and Varela's (1980, 1992) autopoietic theory and the theory of complex systems. We do not propose this synthesis lightly, nor are we suggesting it as useful metaphor. We are proposing a hypothesis about the constitutive nature of social systems.

Despite some confusion by the originating authors, it can be argued that autopoiesis compels a relativist epistemology (Maturana, 1988b) whilst implying the existence of '. . . a reality independent of an individual' (Mingers, 1995: 114) and hence a realist ontology. Complexity theory derives from the natural sciences and assumes a realist ontology. When applied to social systems, however, it has been argued to be compatible with a relativist epistemology (Cilliers, 1998, 2000).

The synthesis proposed here provides an internally consistent approach to understanding the relationship between many levels of sociality. In this it has the potential to re-unite current scientific oppositions and avoid unnecessary pluralism within social science.

Why autopoiesis and complexity – are they compatible?

There are a number of reasons why, at least intuitively, a synthesis of autopoietic and complexity theory is alluring. Autopoietic theory provides a basis for understanding the characteristics of the micro-level agents that make up social systems – human individuals. Complexity theory provides a basis for understanding how these characteristics influence the range and type of macro-level phenomena that will arise if such individuals are brought together and begin to act in co-ordinated ways.

Both theories are well established, each having its own body of associated literature. Furthermore, the conceptualization of biological systems proposed within autopoietic theory is philosophically consistent with the underpinnings of the theory of complex systems. These bodies of work overlap to the extent that both conceive of micro-agents as bounded (autonomous) self-referential systems.

Both of these areas of theory have been previously applied to social science but largely as separate areas of inquiry. For example, autopoietic approaches to society have been addressed by authors such as Luhmann (1990), Mingers (1991) and Zeleny (1991). Some of these authors argue that social systems are autopoietic rather than simply being comprised of autopoietic entities (humans), but such an extension remains controversial (Bednarz, 1988; Mingers, 1995) and in our view unnecessary. Furthermore, such approaches continue the micro–macro divide by focusing autopoiesis on only the macro structures of social systems.

In the case of complexity theory, important contributions have been made by Eve et al. (1997) in application to sociology, Kennedy and Eberhart (2001) in cognitive science, Cilliers (1998) in cognition and language, Arthur et al. (1997) in economics, Boisot (2000), Marion (1999), Kauffman and Macready (1995), McKelvey (1997, 1999) in organization science, and Stacey and colleagues (Stacey, 1996, 2001; Stacey et al., 2000) in management. Earlier contributions that are relevant but not explicitly linked to the 'new science' include those of Hejl (1984, 1993).

In light of these observations it is surprising that no substantive attempts have been made to combine the perspectives of autopoiesis and complexity, the work of Luhmann (1990) and von Krogh and Roos (1995) being possible exceptions.

In terms of applying these ideas to the study of social phenomena, we are aware of a number of problems. First, there has been considerable debate about whether it is feasible or desirable (Mingers, 1995) to treat social systems (as opposed to the constituent parts – people) as autopoietic. This debate is beyond the scope of this article but issues include: a tendency to confuse the productive components of the system and the things produced (Bednarz, 1988; Goldspink, 2000b; Kay, 2001; Stacey, 2001; Varela et al., 1974); the ability to define the boundary of the system (Goldspink, 2000b; Mingers, 1995; Stacey, 2001) and a problem of applying theory from one discipline to another (Luhmann, 1995). So autopoietic theory cannot be simply translated across from its biological origins and used as a basis for social explanation. Second, while it has become common to do so, the legitimacy of treating social systems in a manner similar to natural complex systems is questionable (Cilliers, 1998). There are distinctive aspects of social interactions, including the reflexive capability of social agents, their ability to observe at multiple levels (as opposed to only locally) and the existence of language as a basis for highly flexible and rapid reciprocal influence which make social systems different from natural systems. For complexity theory to be applied to social systems it needs to be established that there are reasonable grounds for assuming that social systems do operate (at least within bounds or under certain conditions) in a manner comparable with natural systems. Alternatively, and this is the path we adopt, it needs to be established that complexity theory can be extended to apply to social systems. We argue that a pathway to this extension exists within the theory of autopoiesis.

The phenomenology of social systems

Autopoiesis: understanding the mechanics of sociality

Autopoietic theory has its origins in biology and readers with a social science background may not be familiar with many of the concepts used. For reasons of space, only a few core concepts are described here. A clear account of the overall theory may be found in Mingers (1995) and a clear exposition of key concepts in Whitaker (1996). The elements of autopoiesis, which provide a framework for understanding the mechanics of sociality are:

Operational closure: According to the theory, operational closure is a necessary consequence of the biology of living systems. This concept defines the way in which the individual relates to the environment, including the social environment.

Structural coupling: Describes the biological implications of recurrent interactions between individuals in the environment and we argue provides the engine for the emergence of social phenomena.

Language: Derives from processes of distinction and the nature of cognition – is a particular form of structural coupling of importance in human systems.

Operational closure

Autopoietic theory (Maturana & Varela, 1980; Varela, 1979; Varela et al., 1974), provides a description of the self-producing dynamics that distinguish living systems from non-living systems. The central thesis is that living systems are characterized by their self-producing (autopoietic) nature. Of more significance to the discussion here, the theory describes the processes and rules underpinning the maintenance of this self-production and provides an explanation for the mechanisms of cognition and language (Maturana, 1988b; Maturana & Varela, 1992; Varela et al., 1992). However, the theory was not developed to account for social behaviour and its originators have not been enthusiastic to discuss this application of their ideas. Some writers have asserted that social systems themselves are autopoietic (see, e.g. Luhmann, 1990; Zeleny, 1991) and this has led to considerable debate about the appropriateness of any extension of the theory into the social domain. In the framework we propose here it is important to note that we do not consider social systems to be autopoietic. Rather we argue that the theory provides a foundation for understanding the elemental mechanisms of social systems and how social behaviour can arise from, and is constrained by, the characteristics of human individuals. As such, autopoietic theory could be seen to provide an understanding of the biological causal processes from which observable social behaviour derives.

When applied to humans and their behaviour, autopoietic theory raises a number of important challenges. Some of these are at odds with assumptions commonly found in social theory. First, it is asserted that an individual's behaviour is determined by particular states of nervous system activity (Maturana & Varela, 1980). Until one appreciates the rules that define that activity, this does not appear profound. Specifically, Maturana and Varela claim that the nervous system's activity is 'operationally closed'. This means that, in all cases, nervous system activity results from and leads to further nervous system activity in a closed cycle (Maturana & Varela, 1980), and therefore is a 'self-referential system' (Hejl, 1984). Possible and actual changes in the state of the nervous system are dependent on the nervous system's existing 'structure' or states and not external environmental forces. Environmental forces are usefully considered as *perturbations* – they act only as triggers for change – but it is the nervous system's structure that dictates which forces can be a trigger (Mingers, 1991; Varela et al., 1992). Consequently, the process of structural change and any behavioural change emerging from it occurs 'autonomously' for each individual. In other words, changes to the structure of one person's nervous system, and consequently their behaviour, will be unique to that person. The environmental perturbations that act as a change trigger in one person will not necessarily trigger a change in another, or if they do, the change that is triggered may take a different form and/or have different implications for the viability of that person in his/her environment, given his/her history of interactions. It is this 'accommodation' of perturbation that constitutes *cognition* and this approach is markedly at odds with the common assumption that cognition involves 'representation' of the 'real' world within the brain (Cilliers, 1998; Kennedy & Eberhart, 2001; Varela et al., 1992).

Structural coupling – the basis for sociality

As a result of the process of continual accommodation an individual will experience what Maturana and Varela (1980, 1992) describe as a 'structural drift', or a gradual change to the state of their nervous system. The nature of this change will be defined by the individual's history of interactions with the environment. Over time this process traces a unique history – its ontogeny.

From the perspective of any given individual, all other individuals form a part of the environment and add a source of additional perturbation. When two or more people interact, their ontogenies will be mutually influenced as each person's nervous system adjusts its structure in response to the perturbations created by the other. When these interactions become 'recurrent' – that is repetitive and ongoing – individuals can become what Maturana and Varela term 'structurally coupled'. Here we have the most basic element of sociality and one that can be applied to all organisms with nervous systems, even very elementary ones. A history of recurrent interactions leads to a structural congruence or commonality of experience between two or more people – their behaviours become tuned to one another in a reciprocal 'dance' maintained in and through their relating.

The degree of structural coupling that arises when two or more individuals interact is a fundamental factor in determining the dynamics and emergent behaviour of the resulting structurally coupled system. This is explored further in the section on complexity.

Language

Significantly, humans have a capacity for a distinctive type of behaviour made possible by the complexity of their nervous system – this behaviour is language (Maturana, 1988a; Maturana & Varela, 1980). Remembering that from the perspective of any given individual, the actions of others operate only as environmental triggers for structural change; people trigger change in one another through both behavioural and linguistic means. From this perspective, language is simply a very flexible form of behaviour. From an autopoietic perspective, language does not encapsulate 'meaning' that is then transmitted from one brain to another (Varela et al., 1992).

Recurrent interaction through both behavioural and linguistic means gives rise to what Maturana and Varela describe as a 'consensual domain'. That is, '. . . a domain of arbitary and contextual interlocking behaviours' (Mingers, 1995: 78). These interlocking behaviours both trigger and reinforce commonalities in structure between individuals and over time may themselves become the object of distinction in language. Linguistic behaviour operates recursively as people distinguish aspects of the environment, distinguish their own distinctions and those of others and then further distinguish 'distinctions of distinctions' etc.

In the context of studying social systems or institutions, these concepts provide an explanation for the way in which individuals both coordinate their behaviours with one another and develop mutual orientations to their context. A social structure is therefore a domain of structural coupling – a consensual domain. These patterns may take on a certain coherence and robustness. Whilst individual members may change, the broad patterning may remain much the same. The pattern constitutes an apparent closed system of behaviour at the level of the aggregate or system of interacting individuals. This pattern is the observable product of the time and context specific interactions occurring between individuals via the mechanism of structural coupling.

Implications of autopoiesis

What autopoiesis provides is a model of how phenomena (which we may now call social phenomena) emerge from the complex (and non-linear) interplay between the heterogenous (in having unique ontogenies) agents (people) that make it up.

In the words of Holland (1998: 122) '. . . Emergence is above all a product of coupled, context-dependent interactions. Technically these interactions and the resulting system are nonlinear.' Consequently, autopoietic theory provides for an understanding of how social structures form and are shaped by the biological characteristics of their constituent (autopoietic) entities. Mapping this onto the three levels suggested by critical realism, we can see that the biology of the constituent agents is real or intransitive. It shapes and constrains the nature and types of interaction possible between agents. Phenomena that are generated through structural coupling correspond to the actual – emergent patterns that result from time and context specific interaction between real biological entities. However, these patterns are distinguished by observers (who may also be the actors that give rise to the patterns). The distinctions made by observers correspond to the empirical level. In social systems however, the making of such distinctions immediately feeds back and is one of the factors that influence the time- and context-specific patterns being distinguished.

So although social structures are emergent and a product of the interaction of individuals, they can and do influence behaviour in much the same way as physical aspects of the environment. They have causal effect and hence ontological status (Bhaskar, 1997). Philosophically then, autopoiesis and complexity take us away from a crude empiricism which asserts the primacy of sense experience, and from idealism which denies the existence of a 'reality out there'. Both the biological processes and the patterns of interaction between biological individuals constitute intransitive structures. As such, both have ontological status. They can and often are distinguished by observers – as either physical or causative objects.

The key aspects of our position derived from autopoiesis can now be summarized: humans exist in and through domains, which are the product of their structural coupling with an environment. This environment is the world around them including other humans and exists both physically and causally. The domain is a complex product of the context and time-specific interactions into which the individual enters. Included in this are the linguistic interactions that arise as individuals generate linguistic distinctions about that environment. As humans enter into reciprocal interaction over time, there emerges, as a consequence of structural coupling, a certain alignment of their behaviours, including their linguistic behaviours. Hence we can refer to the resulting domain as a consensual domain. This domain now forms the basic unit of social analysis, and exists in a causal sense but not a physical one.

In human social systems, individuals come together in many potentially intersecting consensual domains ('work groups', 'families', 'sports clubs'), which are a part of larger more extensive domains ('corporations', 'subcultures', 'nations'). An observer may distinguish these as separate and each may usefully and meaningfully be treated as operationally closed in that the recurrent interaction is uniquely determined by the structures of the participating individuals and their individual and collective histories of interaction within a particular environment. Their interaction is self-maintaining and self-referential. This view of social systems as networks and heterarchies of intersecting systems of operationally closed and structurally coupled individuals makes it possible to approach any level or scale of social system in essentially the same way and to analyse them in much the same manner.

As such, autopoietic theory provides us with the mechanisms through which individuals relate to their environment and each other, through the notions of operational closure and structural determinacy; it provides an explanation for the generation of language; and provides us with a description of the basic unit of sociality through the process of structural coupling and the generation of consensual domains. Where autopoietic theory is limited is that it fails to provide us with a language or set of concepts with which to describe the behavioural dynamics of individuals in structural coupling, the dynamics of the interactions between multiple sets of structurally coupled individuals or intersecting consensual domains, or a way to understand the reflexive role of language in the maintenance of these domains. We argue in the next section that complex systems theory provides these explanatory tools.

Understanding the dynamics of sociality: complexity

As Burrell and Morgan (1994) have identified, a significant proportion of extant social theory is ill suited to understanding the dynamics of social systems, in particular, endogenous disorder. How is it that systems which many argue arise through the conscious intent of their actors, nevertheless display considerable disorder? We argue that it is a commitment to trying to understand sociality using linear/reductive concepts/models along with an inappropriate emphasis on intentionality as the primary source of order that is problematic. Within the original work, autopoietic systems are argued to be constitutively conservative – making minimal structural change to maintain their autopoiesis. This theory also suggests a dominance of convergent rather than divergent dynamics. Nevertheless, the autopoietic view of the mechanics of sociality presented so far provides a non-linear constitutive model as a foundation for exploring social dynamics in contrast to the more common linear models. We are concerned, therefore, to understand better the implications of this non-linear model for our understanding of endogenous social ordering.

Research into complex systems demonstrates that systems containing significant non-linearity can demonstrate a wide range of behaviours (Bak, 1996; Cohen & Stewart, 1994; Kauffman, 1993; Lorenz, 2001; Prigogine & Stengers, 1985). A key contribution of complex systems theory is that it has expanded our capacity to distinguish classes of behaviour characteristic of non-linear systems and provided insights into the micro-conditions associated with the emergence of those classes of behaviour. To date, however, the theory has concentrated primarily on natural complex systems. A number of schemas have been adopted to categorize the range of behaviours possible. For our purpose a three-category schema is sufficient. The categories we describe are stable, quasi-stable and unstable or chaotic.

Stable systems: Technically a complex system is described as stable in response to a class of triggers if the dynamics show little or no change within a finite time following such a trigger (Stewart, 1990). A system that is stable is often described as following an 'attractor'. This attractor may be a point (i.e. the system is at rest – in a state of equilibrium) or cyclical (i.e. the system repeats a fixed pattern of states – displays homeostasis).

Quasi-stable systems: It is possible for a system to display characteristics that we would label as quasi-stable (Kauffman, 1993; Stewart, 1990). In such a system a trigger may initiate a move to an alternate pattern of behaviour. A quasi-stable system may have multiple stable states but be sensitive to certain triggers. When such a trigger event occurs, the system bifurcates or becomes temporarily unstable before moving to a new attractor.

Unstable systems: A system would be deemed unstable where it demonstrates no discernable stable pattern of dynamics. In such systems an observer would determine that there is constant change and no apparent order. A system is described as unstable if a perturbation is amplified and the dynamics of the system change and never settle back to the previous trajectory following a perturbation (Stewart, 1990). Chaotic systems are unstable. They do exhibit pattern (i.e. their behaviour is non-random) but due to their fractal organization they never repeat a prior state (Stewart, 1990). In such systems changes unfold rapidly and the course of events is history sensitive – can be changed by apparently minor events.

Kauffman (1991, 1993, 1996) has shown that the two key parameters that influence the dynamics of a complex system are the number of agents (N) that comprise it and the density of their connection (K). Increasing N and/or K in a system will change its dynamics through a series of critical thresholds from stable to unstable behaviour.

Before we move to explore the implications of these natural scientific observations to social science, it should be remembered that the categories of stable, quasi-stable and unstable are distinctions made by an observer. A lot rests, therefore, on where the observer chooses to draw boundaries and on the level of analysis being undertaken. Applying the categories to social analysis, for example, some political systems could be described as unstable (e.g. some South American governments) and others as quasi-stable (e.g. Italy). The changes in government in Italy have, however, been regular since the end of the Second World War. The quasi-stability discernible at the level of ruling party seems to be part of a higher order pattern or attractor of how government works in post-war Italy. An alternative conception or analysis at different levels leads to different attributions of order.

Notwithstanding the above caution, provided the observer retains a consistent perspective, it may be possible to study a set of patterns characteristic of a particular social situation and to draw meaningful inferences as to how these patterns arise from the micro-processes operating at lower logical levels. We can then offer plausible arguments as to how the observed order arises as a consequence of the operation of the system as distinguished.

Distinguishing social complex systems

We would argue that in terms of further bridging the micro–macro divide in social theory, complexity theory offers a basis for understanding:

- the range and type of dynamics possible between individuals that are in structural coupling, in particular as a product of their non-linearity;
- the range and type of dynamics possible when consensual domains interact;
- the properties which influence the dynamics of such systems and the mechanisms by which they act.

To link these issues in the broader context of social theory we examine them under the headings of, recontextualizing the role of intentionality, divergent social processes and convergent social processes.

To apply complexity insights to social systems there is a need to understand the distinctive qualities of social complex systems and how these impact on the behaviours that they may give rise to. These can be expected to differ from those of natural systems. There is also a need to recognize that inquiry into the behaviour of social complex systems itself takes place within and is constrained by the very phenomena under study.

Social systems are complex systems of a particular class. In the theory of autopoiesis we have the basis for describing the particular nature of the constituent individuals, how they come to interact and the fundamental dimensions on which they can interact. We notice that these individuals have a capacity for language and that language plays a prominent role in their structural coupling. Language makes it possible for individuals to distinguish 'self' from 'other' and hence these agents are also reflexive. This is quite unlike natural complex systems. Language provides a potent source of behavioural flexibility – one unmatched by natural agents within human timescales. Furthermore, reflexive agents can observe the behaviour of networks in which they participate and these observations can and often will influence their behaviour. This also is quite unlike many natural complex systems.

In natural systems the behaviours of individuals (atoms, molecules, ants) are triggered by local influences only (Resnick, 1997). In other words, in natural complex systems macro-phenomena arise as a result of the complex local interaction of micro-agents. Feedback from macro to micro is either not possible or is indirect – by means of changes induced in the environment which might be felt locally. In systems with cognitive reflexive agents this macro-to-micro feedback can be more direct as the agent distinguishes macro-patterns and changes his/her behaviour as a result. It does not matter if the individual 'correctly perceives' or 'selectively' or 'mis-perceives' the macro behaviour. It will seldom, if ever, be possible for him/her to anticipate how his/her own behaviour contributes to it due to the presence of non-linearity. The presence of this feedback loop does not, therefore, necessarily provide a basis for negative feedback or serve to stabilize the behaviour of the system. On the contrary, it adds significant complexity and additional non-linearity, adding to the analytical irreducibility of the system as a whole. The inherent plasticity of behaviour made possible by language further adds to the non-linear dimensionality of the system and so complex systems comprising human reflexive agents can be expected to generate a very wide range of behaviour indeed. They are both highly dimensional and the dimensionality is itself under the control of the system. Social systems can, therefore, generate what Kauffman (1991) called minimal and structural change in that, as a result of the operation of the system itself, both states ('meanings') and structure (relationships) can be modified.

Autopoietic (biological/physical) systems are 'constitutively conservative', i.e. actively compensate for external triggers in order to maintain their viability in their environment (Maturana & Varela, 1980; Varela, 1987). At the level of the biological individual then we can expect to see a predominance of homeostatic or stable dynamics. This is no surprise – it is necessary for life. Interestingly though, at the level of species more diverse dynamics are observed (as a result of sexual combination and random mutation) and this comprises the basis for selection of more viable biological entities. Higher variability has been demonstrated to be necessary to survive in uncertain environments (Depew & Weber, 1997, 1998; Kauffman, 1996) – consistent with Ashby's (1974) theory of 'requisite variety'. Social systems appear to demonstrate a wide range of behaviours from robustly homeostatic to chaotic. Indeed, from the description proposed here, it would be difficult to identify any natural system that has more intrinsic flexibility and adaptability than a social system. As such, we would define social systems as a particular class of complex system, with particular attributes and dynamic properties.

The role of intentionality in social dynamics

The source, form and nature of ordering processes in social systems are also significant in terms of how the micro–macro divide is bridged. Much social and institutional theory assumes a prominent role for intentionality or rationality as a source of social order. For example, within institutional theory, order is commonly assumed to be a result of common goals (companies, clubs) or common interests (political systems). Within economics, order is posited as a product of rational utility maximization. Within sociology too, intention is seen as a major contributor to order. Hejl (1984: 69) recalls Max Weber's definition of social action as an action 'which through the intention of the actor or actors is related to the behaviour of others and whose course is oriented at their behaviour.' For Weber then, social behaviour was intentional and cooperative.

In systems theory two types of goal-directed behaviour are recognized (Checkland, 1988). These are teleology, or explicit goal directedness which is consistent with that assumed by management theory, for example; and teleonomy, or apparent goal directedness. Within social theory there is often a failure to distinguish between these two concepts when discussing intentionality. Within the context of the unfolding discussion it should be clear that any explicit goal directedness present is at the level of the autopoietic individual not at the level of the social system. Social systems comprise individuals with multiple (often conflicting) explicit intentionalities derivative of their individual ontogonies. Any purpose attributed at the level of the social systems must be teleonomic – it is a distinction made by an observer based on his/her having recognized a pattern at the level of the system. That pattern will reflect the 'apparent purpose', which results from the interplay of behaviours (intentional and otherwise) at the level of the individuals.

Within complexity theory, processes that give rise to order in the absence of an external directive agent are referred to as self-organizing processes (Bak, 1996; Kauffman, 1993). Autopoiesis is one example of an autonomous system that exhibits self-organization. In this case it is a relatively stable phenomenon emerging out of the metabolism of the cell (at the level of cell biology) and the structural determinacy of the nervous system at the level of an individual animal or human. Self-organization is a process of getting 'order for free' (Kauffman, 1993) and is a product of non-linear interaction.

In social systems a recurrent pattern may also result from self-organization. In this case it will be a result of a complex interplay between the intentional behaviour of the individuals that comprise it and unintended and contingent factors (McKelvey, 1997). The intentional or goal-based behaviour of individuals is just one influence on the whole system behaviour and cannot and should not be expected to be dominant. For example, a business cycle (which results from non-linearity in the processes of economic exchange) would represent a cyclical attractor at the level of an 'industry'. It arises as company management pursue their various goals within a broader industry environment that contains some non-linearity. The business cycle is not what was 'intended' by anyone and it may or may not be possible to locate the source of non-linearity which produces the cyclical economic behaviour. It is a complex product of the interactions of all firms and consumers within the economic and social environments within which they operate. From this perspective, macro-level social order is a complex product of micro-level intentionality and the wider non-linear operation of the system.

Divergent or disordering processes

Social systems have been shown to generate considerable levels of disorder. The origin, source and nature of this disorder require further explanation. If social systems were primarily brought about and maintained by intentionality then we would not expect the level of disorder commonly observed. As discussed earlier, Kauffman (1993) has shown that the two main parameters that influence the dynamics of complex non-linear systems are the number of agents (N) and the density of their connectivity (K). A question then arises; what might be the nature of NK dimensionality in social complex systems? By dimensionality we mean the number and nature of linkages between heterogeneous agents in a system. Transferring Kauffman's concepts to social complex systems, the dimension N is relatively clear. This will refer to either (i) the number of human individuals participating in a consensual domain, and/or (ii) the number of intersecting consensual domains depending on the level of analysis. From the framework developed here it has been established that individuals couple behaviourally (including linguistically). The density of coupling (K) will, therefore, refer to the number of ways in which an individual couples behaviourally with others and/or the number of nodes of intersection between domains, depending on the level of analysis adopted by the observer.

Focusing on the individual level, what might dimensionality of behavioural coupling mean and how might it be measured? There is clearly a need for further research to clarify how such a concept can be applied to social systems. Indeed, this might be considered as a threshold issue for the application of complexity to social systems. What can be argued is that linguistic coupling broadens the requisite variety of potential interactions. People couple in language on many dimensions; every linguistic exchange will invoke and establish a dynamic pattern of interactions which is unique, while being constrained by the consensual aspect of language in the context and history of that social structure. In human social systems then, recurrent interaction is continually maintained in a flux of intertwining webs of linguistic, behavioural and emotional interaction. This is highly dynamic, never being the same from one instance to another. The combined effect of heterogeneity (difference in experience and behaviour) of individuals and this highly plastic basis of interaction adds significant non-linearity and dimensionality. As a result, such systems can be expected to generate highly varied dynamics.

Turning now to the level of intersecting domains; any given individual will commonly participate in the generation and maintenance of many consensual domains ('work team', 'sports club', 'family') concurrently. The presence of an individual common to many domains represents a point of intersection between them. Where domains intersect, each individual participates in giving rise to and integrating different domains of social interaction. As this occurs through structural coupling, it must be appreciated that structural changes and patterns developed by individuals (micro-level) as a result of participating in one domain may 'spill over' into the other domains. Conceivably, what helps maintain integration in one domain may be dysfunctional in another. Thus, the domains will continually disrupt each other at points of intersection. Hejl noted the potential importance of this domain intersection. He states:

> Although social systems are conservative systems due to their organization, they generate phenomena of social change. This can be explained as resulting from the multi-component character of the individuals that constitute them. . . . In internally differentiated societies, social change seems to originate mostly from the interaction of social systems. Social systems always interact through the interactions of their components, i.e. the individuals that constitute the systems.
>
> (1984: 76)

It is inevitable that every individual will be participating in many different domains simultaneously. Intersecting domains have the potential to exhibit very irregular and 'far from equilibrium' behaviour as they continually perturb one another. Again then, the potential for divergent, indeed chaotic, dynamics is very substantial.

In conclusion, contrary to the assumptions underpinning most social theory (Burrell & Morgan, 1994), endogenous disordering processes exist within social systems and can be seen to arise as a consequence of the nature and structure of such systems. From the perspective of the framework presented in this article, order arising from the intentionality of individuals coexists with this 'complexity order' (McKelvey, 1997). When social systems are approached in this way the challenge becomes explaining order not disorder. This is taken up next.

Convergent or ordering processes

Sociologists regularly observe 'norms', 'rituals' and 'conventions' within social behaviour. These are indicative of stable patterns of interaction and behaviour. Following the framework being set out here, these can be seen as patterns of reduced dimensionality of coupling between participating individuals. As a consequence, the system is more stable and thus less adaptive or responsive to perturbation. Note that these patterns need not be the product of rational choice but the product of the operation of the system – they are illustrative of a self-organizational potential. It should be clear that such patterns inevitably arise through structural coupling in a behavioural and/or linguistic domain. The 'norms' are the consensual elements of that domain. The effectiveness of such structures in regulating social interaction does not require rational choice or voluntary participation. Some individuals may choose to adopt the 'norm' or may adopt a pattern of 'blind following'. Both will suffice to stabilize the network.

There is still a need to examine if there are regulatory mechanisms that operate to stabilize the dynamics that result from the intersection of social domains. In order to explain how and why social systems can co-exist and not mutually annihilate, and to explain the possibility of diverse societies reaching a stable state we might expect to find some self-organizational potential for containing it at this level. Kauffman and Macready (1995) have pointed to one such mechanism. Regulation at inter-group level may be achieved by controlling the degree of cross membership.

Kauffman and Macready have shown the importance of the concept of 'patch size' for the stability of systems involving groups and it is conceivable that as the number of groups in which individuals participate increases, the size of intersecting social groupings overall must fall to maintain some order. Reduction of 'patch' size and/or reduction in the dimensional coupling between 'patches' can serve to stabilize otherwise unstable systems involving intersecting social domains.

In conclusion, unlike much extant social theory, complexity theory can help us understand the nature and origins of divergent dynamics as well as convergent dynamics when applied to a social theory derived from autopoiesis. Up to now, the application of complexity to social phenomena has commonly been metaphorical. Here it has been demonstrated that there is a substantive base for its application to social systems albeit with some extension and development. Now the legitimacy of its use in social systems research is established it offers a consistent framework for understanding dynamics at seemingly opposite ends of the scale – high stability and chaos – and points to the factors which shape and influence alternative dynamics in social systems.

Limitations and future research

Although a number of issues have been addressed in this article there remain a number of key areas where further definition is required and research is needed.

The area in greatest need of explication is the definition of dimensionality in the context of social interaction. We have proposed a connection between Kauffman's NK model and the notion of structural coupling as described in autopoietic theory. This idea has great promise but clearly needs considerable development.

There is a need also to respond to McKelvey's insight that much of what is interesting in social dynamics may be the result of the interplay between alternative sources of order, in particular, the order that results from complex organization, and intentional order. The nature of this interplay is still poorly understood.

The theoretical framework set out here lends itself to implementation, testing and development using the rapidly advancing approach of computer simulation (Conte et al., 1997; Gilbert & Conte, 1995; Gilbert & Troitzsch, 1999), in particular multi-agent simulation (Brassel et al., 1997; Goldspink, 2000a, 2002). This method would provide an effective means for experimenting both with what NK dimensionality means and the implications of intentionality of social agents in social complex systems.

Conclusion

In this article, we have presented an argument for a new approach to the consideration of social systems, an approach based upon a synthesis of autopoietic and complexity theory. The basis of our argument stems from a desire for a consistent framework (both ontologically and epistemologically) for understanding the mechanisms or generative processes underpinning the emergence of social systems, on the one hand, and the dynamical or behavioural dimensions of social systems, on the other hand. We have argued that whilst many of the approaches currently available for the consideration of these phenomena provide explanatory value at one phenomenological level of inquiry or another, none provide a consistent framework that links both the constitutive (micro) and emergent (macro) dimensions of social organization.

Autopoiesis provides a model of how phenomena (which we may now call social phenomena) emerge from the complex (and non-linear) interplay between the heterogenous (in having unique ontogenies) agents (people) that make it up. Complexity then allows us to explain the resulting dynamics by describing the generative processes that link empirical observation and causal actuality. Social systems can be seen as a specific class of complex systems and it is autopoiesis that clarifies the distinguishing characteristics of this class, in particular the linguistic/reflexive character of social agents.

In the synthesis of autopoiesis and complexity we have a basis for understanding the mechanics and dynamics of sociality. The two are linked in that it is possible to demonstrate the basis for common epistemological and ontological roots and implications. Together they suggest an adoption of ontological realism and epistemological relativism and hence a position consistent with the philosophy of critical realism.

The theory provides considerable reach across phenomenological levels and hence a bridge between the micro and macro. It does this by:

- describing the mechanisms by which social systems emerge in a way consistent with human biology;
- describing the nature of language in a manner consistent with human biology and how language influences the emergence of social structures;
- explaining how the difference between individuals is both a product of their biology and their history of involvement in social processes, and how the distinct ontogeny of each individual gives rise to heterogeneity, and therefore non-linearity, at the level of the social. This heterogeneity then explains the mechanism by which convergent and divergent changes arise in social systems;
- explaining the mechanisms that influence the dynamic potentiality of social systems in particular those that serve to regulate on the one hand and generate divergent change on the other.

The tendency of past theoretical approaches to resolve the micro–macro tension by discounting the ontological status of one side or the other is resolved by explicating the mechanisms by which the two interact. Social phenomena are thus regarded (due to their demonstrable derivation from micro-processes and effect on those micro-processes) as having ontological status.

Unlike the existing state of affairs, where almost every phenomena in social systems is approached using a different theoretical lens, many of which are incompatible, here we have a foundation for an integrated approach. Although some will no doubt argue that the current state of affairs provides a rich and pluralistic environment and an adequate basis for day-to-day decision making, others like us, will find this unsatisfactory. Clearly a framework that can provide for an integrated perspective of and explanatory theory covering phenomena from the biological nature and constraints which govern human cognition and behaviour, through to the dynamics of aggregate and emergent structures, is attractive.

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