The Dynamics of Self-Organization: Neglected Dimensions

Christopher G. Hudson

ABSTRACT. The following reviews the promises and limitations for social work of self-organization theory, an integral part of the emerging field of complex systems. Self-organization refers to the capacity of many systems to spontaneously develop novel forms of organization with little external interference. The primary focus of the review involves what the author contends are several neglected dimensions of higher level self-organizing systems, specifically: (1) the role of consciousness and intentionality; (2) the capacity for self-selection as a means of seeding self-organizing processes; and (3) the possibility that some forms of self-organization are based on nonlocal processes involving the synchronistic correlation between separated parts of systems.

KEYWORDS. Self-organization, complex systems, consciousness, self-selection, nonlocality

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Central to the profession of social work is the belief that it has the knowledge, ability, and responsibility to intervene to bring about change in individuals and systems of concern. However, social work has demonstrated considerable ambivalence about this mandate. On one hand, it has rejected simplistic technocratic quick-fixes, and on the other hand, it has found it difficult to move beyond the rhetoric of self-determination, collaboration, and facilitation to develop a more rigorous and comprehensive theoretical perspective. Frameworks that have been proposed to fill this need include the systems and ecosystems models, yet recent critiques (Hudson, 2000) have argued that they have been largely based on now outdated general systems and equilibrium theories. At the same time, many fields have been incorporating complex systems or non-equilibrium theories (Warren, Franklin, & Streeter, 1998). One such theory–self-organization–is of particular relevance for social work since it specifically identifies many of the dynamics through which systems, individuals and larger groups, independently manifest novel, and often adaptive, forms of organization with minimal external intervention.

The need to define a coherent theoretical framework, one that simultaneously supports the profession's practice mandate yet is grounded in both the ethics of self-determination and a rigorous understanding of the sources of change, has become increasingly important. The ascendence of the biological sciences in recent years, both as a result of developments in genetics and the incorporation of neo-Darwinian evolutionary models into many of the social sciences, has in many ways supported a laissez-faire approach to social problems, even one echoing the social Darwinian philosophy of Herbert Spencer that actively promoted the "survival of the fittest" and purification of the gene pool at the expense of the indigent.

The following review will focus on only one aspect of the need for an integrative model involving the promises and limitations of the theory of self-organization for social work. It will overview this theory and its foundations, specifically, several of the dynamic processes found in self-organizing systems that have been identified in the literature. The primary concern of this article are some dimensions of self-organizing systems that have been neglected by most self-organization theorists and which may be particularly important for professions such as social work if they are to draw on such theory. These involve the role of *consciousness*, specifically when it is understood as including intentionality; the *self-selection* of individuals and groups as a process that compliments social and natural selection; and *nonlocality*, or the idea that self-organizing systems may be based on not only local interactions of their component parts, but sometimes also synchronistic connections between spatially or temporally separated components.

BACKGROUND[1]

The person most associated with self-organization theory is Ilya Prigogine, who in 1977 received a Nobel Prize for his discovery that self-organization occurs in dissipative systems (1984). These are systems that involve the continual transformation of energy and information, which exist at far from equilibrium conditions, which do not follow the rules of the classical sciences, and which exhibit irreversibility (Bütz, 1997). More recently, Stuart Kauffman (1995) has challenged neo-Darwinian orthodoxy by arguing that self-organization is a "undiscovered principle of nature" and that it and natural selection are the twin engines of the biosphere. He suggests that while self-organization may account for sudden evolutionary transitions, for example, from one species to another, natural selection functions to fine tune new structures only after they have emerged.

Definitions of self-organizations abound. However, a review of such definitions suggest that there is considerable consensus that the phenomenon minimally involves three primary features. (1) The creation of characteristic structures or organizations (Merry, 1995: 172-4). (2) Creation of such structures happen with a minimum of external input. For example, one author pointed out that a system is self-organizing if "it acquires a functional, spatial, or temporal structure without specific interference from outside" (Haken, 1988). (3) Finally, this organizing process happens with apparent spontaneity. For instance, Flake (1988) suggests that "Self-organization [is] a spontaneously formed higher-level pattern of structure or function that is emergent through the interactions of lower-level objects." In general, self-organization is usually regarded as involving a system of component individuals or parts whose interactions are governed by identifiable rules and which result in the spontaneous appearance of a higher-order structure.

Although self-organization theory represents a dramatic departure from many of the assumptions of the classical Newtonian paradigm, in some respects it also perpetuates them. The classical paradigm placed consciousness outside of the physical universe, ultimately divesting it of any efficacious role other than as an observer and rational knower. This stance laid the foundation for naturalism, or the idea that the only reality of significance is physical reality. Physical reality, in turn, is conceived as consisting of elemental parts or atoms which are assembled into progressively more complex systems to generate the phenomenal universe. A key element of the atomistic philosophy, which dates back to the Greek philosopher Democritius, is that causation consists of local interactions between adjacent parts, ultimately, between the most elemental atoms and particles. When the rationalism, naturalism, and atomism of the classical paradigm are considered as a whole, what emerges is the vision of a "clockwork universe," most closely associated with Pierre Laplace, in which it was assumed that if only one has enough information on the initial conditions, one would be able to predict all future events. Self-organization theory departs from this vision in its recognition of a fundamental unpredictability of nature–an insight borrowed from chaos theory–that systems, although based on locally interacting parts, exhibit novel characteristics at progressively higher forms of organization. Yet in other ways, self-organization theory, originating in the natural sciences, has tended to minimize the role of consciousness as an efficacious agent in the natural world. The focus has been almost exclusively on local forms of causation, on those between component systems, and has failed to capitalize on the discoveries in quantum physics involving a profoundly interdependent universe whose causal interconnections have been regularly demonstrated to violate any conceivable theory of local atomistic interaction.

Self-organization theory has also developed in the context of both the notion of emergence and the field of complex systems (Lewin, 1992: 175). Emergence was initially associated with the British Emergentists of the nineteenth century, the most well know of which was J.S. Mill (see McLaughlin, 1992). They rejected Descartes' mind-body dualism and proposed that while the fundamental entities of social and psychological processes may be physical, "when processes reach a certain level of structural complexity, genuine novel properties emerge to characterize the structural aggregates," and that these are not just the additive combination of the underlying components (Makiĉ, 1999). Whereas non-emergent properties are simple functions of the qualities of the underlying components, emergent properties can not be accounted for in such a fashion. As it has evolved, the notion of emergence has both weak and strong versions. The weak version, described above, simply says that the "whole is greater than the sum of its parts." Whereas the strong version asserts some degree of independence of the whole from its parts. The aggregate pattern takes on a causal significance, one in which the parts are replaceable. An organization may continue to have the same character even if there is a complete replacement of employees; computer programs can be copied and operated in various media; or, individuals continue with their identities, even when the cells of their bodies are completely replaced. The strong version also proposes that the higher level system is not only influenced by, but can in turn, influence its component parts, a controversial phenomenon referred to as backaction or downward causation. While some theorists treat self-organization and emergence as synonymous, it would be more accurate to regard self-organization as a particular type of emergence, since emergence does not necessarily imply an obvious structure or organization, and may involve merely emergent qualities. An example is those that manifest when several chemicals are mixed together.

Self-organization theory is regarded as one of several complex system theories (Lewin, 1992). Systems theory can be traced to general systems theory, which focused on problems involving the maintenance of equilibrium, and was initially introduced in the 1940s by Ludwig von Bertanlanfy (1974). However, beginning in the 1970s, considerable work in mathematics, as well as both the physical and biological sciences, went into the development of chaos theory, or the ways that iterated or repeated processes simultaneously exhibited order and unpredictability. Two of the most universal features of chaotic processes that were identified were that they are sensitive to initial conditions, that no matter how long truly chaotic processes are iterated into the future, they will never repeat themselves, and yet they exhibit an identifiable structure (Hudson 1999). Other approaches to nonlinear dynamics include catastrophe theory (Thom), autopoeiesis theory (Mautauana & Varela, 1986), as well as self-organization. These collectively have come to be referred to as complex system theories, the most essential feature of which is that they involve systems that operate at far from equilibrium conditions and produce irreversible outcomes that either involve the breakdown of apparent order (which chaos theory focuses on), the emergence of order (which self-organization theory focuses on), or its perpetuation (which autopoiesis theory concerns).

Although self-organization theory has in recent years been used in fields as diverse as business, psychiatry, human development, psychology, anthropology, economics, as well as the natural and physical sciences, much of its application has taken place on a theoretical level, through the use of its metaphors, and only occasionally has empirical research been conducted. This has most typically involved simulations of biological or social systems of interest using techniques of boolean networks or cellular automata. Stuart Kaufman, one of the theory's originators who conducts various idealized simulations of self-organizing systems, has been accused of practicing "fact free" science (Behe, 1996). But to reject a theory simply because inadequate data or techniques are available for its testing would be folly. Both relativity and quantum theory made theoretical predictions that could not be tested until many years later when technical developments enabled the collection of relevant data. Of greater concern are some of the theoretical limitations of self-organization theory involving the role of consciousness, self-selection, and nonlocality, but before these are considered, this review will now turn to some of the dynamic processes that are usually associated with self-organization.

DYNAMICS OF SELF-ORGANIZATION

It is debatable whether there are any processes that are common to all self-organizing systems, since such systems manifest a variety of types of dynamics. However, there are several that have been regularly cited, and these include: (1) dissipative processes, (2) the operation of local generating rules, (3) the coupling of lower-order systems, (4) "edge of chaos" phenomenon, and (5) the amplification of internal fluctuations or system 'noise.' Other dynamics less frequently cited include semipermeable system boundaries, a minimum level of redundancy, and systemic correlation or coherence (Goldstein, 1995: 54).

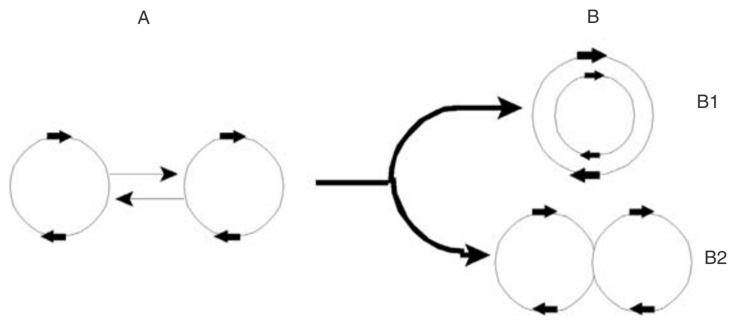
Prigogine was the first to show that *dissipative systems* are a prerequisite for self-organization (1984). Systems that are dissipative are open systems in which there is the continual passage of some source of energy or materials. Self-organizing systems are constantly at work, and thus, must maintain a continuous exchange of matter and energy with their environments (Capra, 1983). Physical examples include the whirlpool or a hurricane, whereas a social example might be a group of street acrobats who produce an act, attract audiences, and take in their admiration and donations, permitting them to repeat their act at a new location. The passage of ample energy and resources through the system is a necessary, but not sufficient, condition for the intervening self-organizing process.

Local generating rules are also considered by many to be central to self-organization. These are the rules or principles that govern interactions between the component parts of the system. Biological examples abound, and these include the rules that tell birds how to fly in relation to one another, forming patterned flocks (i.e., a *V* shape), or how termites should work, forming complex habitats when the activity of the many individuals is aggregated. There is an extensive body of research involving the derivation of the structural consequences of rules governing human interactions, when they should cooperate or compete with one another, and the implications of these rules for overall social patterns (Axelrod, 1997; Holland, 1998). Many trends that social workers encounter are not always driven by singular top-down policies, but often by bottom-up interactional rules. For example, the deinstitutionalization of mental hospitals has often been attributed to the community mental health program launched by President John F. Kennedy, but there is compelling evidence that it is at least as much a consequence of changed state commitment laws, practices, and attitudes, all of which increased the difficulty of psychiatric commitment as well as the likelihood of hospital discharge. Thus, analysis of the operation of any system calls for an identification of the rules that govern the transactions between the local actors. These rules typically govern the ways that individuals cooperate, compete, or attempt to control one another.

Self-organization also occurs when initially independent systems merge or combine, a phenomenon known as *structural coupling* (Merry, 1995: 47; Maturana & Varela, 1987: 88). When a collection of individual systems–whether they are cells, persons, or nations–interact with sufficient frequency they tend to become interdependent as each is pressured to specialize in particular functions, roles, or products, and thus, become reliant on one another. In time, the original individuals may become parts of a larger system. One may be incorporated by another in a parasitic or symbiotic relationship, or several might become integrated on a equal footing, for example, several states may become a federated nation. Such coupling is ubiquitous throughout biological and social evolution. It is driven by the dissipative flow of energy through the larger proto-system and is governed by the negotiation and crystallization of local generating rules that structure the evolving transactions. Erwin Laszlo suggests that the coupling of lower-order into higher-order systems is a function of the lower bonding energies that exist on the more complex system levels (1996) (see Figure 1).

Closely related with structural coupling is the coupling of separate processes, one type of which has been referred to as "metasystem transitions" (Heylighen & Turchin, 1995). These consist of the progressive overlay of one system of control over another. Computer programs are developed to control other computer programs; a dictator acquires an army to keep his population in check, and a secret police to keep his army under control, and so on. Simple reflexes are organized into more

FIGURE 1. Structural Coupling: Two Outcomes



A. Two systems in mutual interaction. B. When interaction becomes sufficiently strong or recurrent, either (B1) one system incorporates the other, or (B2) the two systems link together to form a single system, but preserving the identity of the component systems.

Note. Adapted from Humberto R. Maturana, & Francisco J. Varela (1987). *The Tree of Knowledge: The Biological Roots of Human Understanding.* Boston: Shambhala

complex reflexes, into general response patterns and complex motivational systems. While self-organization is usually regarded as an emergent bottom-up process, it is also one that includes the emergence of top-down controls as key components of complex adaptive systems.

Several researchers have theorized that the *edge of chaos* is another precondition necessary for or conducive to self-organization (Packard, 1988; Waldrop, 1992; Richards, 1996; Lewin, 1992; Prigogine,1996). Prigogine points out that many natural systems spontaneously organize themselves while on the borderline between order and chaos (Zohar, 1994: 199). He argues that the maintenance of organization in nature cannot be achieved by "central management," but only through self-organization: "Self-organizing systems allow adaptation to the prevailing environment . . . and makes the system extraordinarily flexible and robust against perturbations from outside conditions" (Prigogine, 1996: 71). It is argued that systems require novelty and variety, and that when repetitive implementation of local activity rules result in processes that produce an optimal level of variety, one that falls within manageable bounds, the possibilities for self-organization are maximized.

Finally, several theorists have pursued the above line of reasoning and proposed that self-organizing systems require an optimal level of *internal variety*, *noise*, or *fluctuations*, some of which become amplified to become the larger structural patterns. For example, Prigogine and Stengers (1984) argue "When an open system is far from equilibrium, under the influence of a driving force, random fluctuations either internal or external to the system are amplified within the system, involving systemwide communication, and experimentation occurs with possible new configurations." The tendency for self-organizing processes to produce a selective or retained ordered configuration has also been referred to as the "order from noise" principle by Heinz von Foerster. It has been suggested that both Prigogine's and Foerster's principles may be instances of a "principle of selective variety" that suggests that "the larger the variety of configurations a system undergoes, the larger the probability that at least one of these configurations will be selectively retained" (Heylighen, 1992). Any of these dynamic processes–the dissipative flow of energy, operation of local activity rules, structural coupling, development at the edge of chaos, or the amplification of random fluctuations–may be functional or dysfunctional. While no one has been able to identify with any precision the necessary and sufficient conditions for self-organization to occur, the set of these processes provide an overall framework from which self-organizing systems can be analyzed.

Applications to Social Systems. Self-organization has been identified in a wide range of physical, biological, psychological, and social systems. Both biologists and social theorists have, however, narrowed the concept, isolating a particular type of self-organization referred to as autopoiesis or social autopoiesis. Humberto Maturana and Francisco Varela (1987), two Chilean biologists, have classified complex systems into those that are allopoietic and autopoietic. Unlike allopoietic systems that are pre-programmed, autopoietic systems–of which most life forms are examples–are self-organizing and self-regulated. They exhibit not only the capacity to alter their internal instructions to adapt to new conditions, but also to self-produce and to replicate. Thus, while the chaos and self-organization theories are concerned with transitions either into or out of disordered states, autopoiesis theory focuses on the maintenance of order, but only in a dynamical sense of the term. Maturana and Varela applied autopoiesis theory to both biological organisms and human cognition.

Niklas Luhmann also has done extensive work in the development of a theory of social autopoiesis, applying it to such diverse areas as the law and social ecology (see Bailey, 1997). Luhmann argued that social systems are manifested primarily through the linguistic domain, that their character is a function of the interactions among their members, especially their frequency, extent of connectivity, and types of memberships. The influence of the system as a whole on its members, and vice versa, is seen as recursive and iterative, realized primarily through patterns of communication (1980). He was particularly interested in identifying what the constituent elements are that a social system "self-produces," arguing that the essential components or units of a society are not individual persons, but instead, communications. He suggested that communications are, in a fashion, similar to Dawkins theory of memes, self-producing, as well as self-referential. For example, in his extensive analysis of law as a social system he points that law is a self-referential system that maintains and replicates its self:

> . . . for a theory of autopoietic systems, only communication is a serious candidate for the position of the elementary unit of the basic self-referential process of social systems. Only communication is necessarily and inherently social. Action is not. Moreover, social action implies communication. . . . Therefore the theory of autopoietic social systems requires a conceptual revolution within sociology; the replacement of action theory by communication theory as the characterization of the elementary operative level of the system. (Luhmann, 1986: 177-8)

Luhmann emphasizes the circular, tautological, and self-referential aspects of systems of meaning within which each element defines the other elements, but none have independent meaning outside of the particular system under consideration. As self-referential processes, communication systems define, maintain, self-produce, and replicate themselves, much as living organisms do. Although predating Luhmann's work, the work of R. D. Lang (1961) on communication patterns associated with schizophrenia clearly exemplifies the self-referential character of many complex meaning systems.

In recent years, the theories of self-organization and social autopoiesis have been applied to a variety of domains in addition to the law, including cognition, organizational dynamics, accounting, narrative therapy, career advancement, and family dynamics, to mention a few examples. As a relatively recent addition to the array of complex systems theories, social autopoiesis fills an important gap, not only in that it specifically focuses on higher-level social systems, but also on their phenomenology, especially as it is experienced internally by its participants through its self-referential systems of meaning. Thus, while much important work has been done on clarifying the dynamics of self-organization as well as some promising developments on social autopoieses, there are several neglected dimensions of self-organization that theorists and researchers have yet to address, and it is to these that this article will now turn.

Self-Organization and Consciousness. It has been estimated that there have been as about 30 thousand articles and books written on consciousness from 1992 to 2002, yet fewer than one percent of these have addressed what the philosopher David Chalmers (1995) called the "hard problem" of consciousness (Carter, 2002). This involves what has been referred to as qualia, or the inner 'feel' of conscious experience. It is, according to Shear, a problem of understanding ". . . how colorless, soundless, feelingless spatio-temporal structures could ever generate our consciousness with the qualia that fill them so richly" (Shear, 1994: 54; see also Chalmers, 1995). As might be expected, there has been scant agreement about what the term "consciousness" should refer to. Most definitions have often included one or a combination of the following features: (1) aware, awake, or alert state, (2) a sense of existence, (3) knowledge, (4) qualia, and (5) intention, or the tendency of conscious states to be about something or to involve some selection. Other less widely cited features of consciousness involve self-reference, self-talk, or internal narrative. Although the notions of both emergence and self-organization have been widely used in neuropsychological and increasingly in psychoanalytic studies of consciousness, few have investigated the role of consciousness in self-organization, or pursued questions about how the dynamics of conscious self-organizing systems are different from those with little apparent consciousness.

Conscious self-organizing systems no doubt share most of the dynamics previously reviewed in this article, despite the fact that many of these were first identified in natural systems. However, there is evidence to suggest that conscious self-organizing systems, such as the human brain, psychological systems, or social groups, include several additional dynamics. As consciousness involves a fundamental awareness, including a sense of one's existence, the accompanying experience of individual (or group) identity no doubt enhances the capacity of such systems for integration and cohesion. While physical and biological systems are being increasingly conceptualized as information systems, conscious self-organized systems are, in addition, knowledge systems. Knowledge entails contextualized information of a general nature, typically involving overall patterns, relationships, and causes and effects, often represented as models, schemas, or constructions of the self in relation to the world, and it is assumed, an aware knower. Thus, conscious self-organizing systems take in, process, and output not only decontextualized sensory data, but construct this as complex and changing knowledge-based models unlike any self-organizing whirlpool can. Given the awareness, sense of existence, identity, and knowledge-processing features of conscious self-organizing systems, such systems can be best characterized not just by their bottom-up emergent features, but also by the development of top-down controls, including the capacity of the whole to influence the parts in a reciprocal manner. Finally, if intentionality is a integral part of consciousness, then it must also be an integral dynamic of conscious self-organizing systems, and it is this particular dimension that this article will now consider from an alternative perspective.

Self-Organization and Self-Selection. Most contemporary evolutionary theories are based on the theory of natural selection. This is the idea that variations in the characteristics of biological organisms produced by genetic mutation or sexual recombination are acted upon by environmental conditions that favor or disfavor certain of these variations. Those characteristics that confer a survival advantage proliferate over generations and become an integral part of the species. An extension of the theory of natural selection–social selection–has been used widely in the social sciences, for example, in evolutionary psychology. The social environment selects individual characteristics that are to be promoted and those that are to be discouraged. Indeed, such competitive dynamics can be observed in a wide variety of phenomenon, from early childhood socialization to educational and career advancement or mate selection. Both these theories emphasize the power of the external environment to shape individual lives, both within and between generations. In contrast, theories of self-organization de-emphasize the power of external selection in molding the person or group, and instead highlight the inner logic and dynamism of these systems in developing their own organization. There has been much confusion about the relationship between selectionism and self-organization. One suggestion has been that external selection, whether social and natural, serves to tweak self-organizing processes, as well as promoting or eliminating the products of self-organization once they are created based on their adaptive value.

Rarely considered as a dynamic in self-organization is self-selection. Self-selection refers to the possibility that conscious systems, such as individuals or groups, can choose from alternatives whether these involve perceptions, thoughts, or actions. It is a concept that is often used in economics, in studies involving educational or career advancement. Individuals select themselves for a college or career, and only secondarily, seek the social selection or acceptance by an institution or employer. To consider social selection outside of the context of the self-selection of those concerned, can only provide a biased view of what is an interactive relationship between the two processes. Self-selection can be characterized along several dimensions. (1) Selections may be made about possible future states, i.e., a career or mate, or they may concern a current or past state of affairs. Selections regarding current or past conditions involve the ways the individual chooses to look at, define, or interpret them. (2) Selections may be global or particular, involving the kinds of lives people chose to live, or fairly delimited actions such as whether or not to participate in a social event. (3) Selections may also vary based on whether they concern, on one hand, a process or behavior, or on the other hand, some fixed trait. For example, some individuals decide against pursuing certain occupations based on their gender. (4) Individuals vary in their ability to make conscious self-selections and to implement them in the face of environmental realities. (5) They also vary in the ways they make these selections, whether through rational, intuitive, or impulsive forms of decision making. Table 1 provides additional examples of the ways that the various types of selection–self, social, and natural–act on different types of variation, whether this involves behavioral characteristics or fixed traits.

Self-selection is one process among many, although an important one. It is a broad concept involving, at its heart, notions of free-will, motivation, identity, self-esteem, and decision making. Its value is that it permits these realities to be considered in relation to environmental, social, and natural selection. The language of social selection has traditionally obscured the role of individual choice in conscious self-organizing systems, such as individuals or groups.

Self-selection, when applied to developmental theory, takes place within the context of the reciprocal interaction of the individual with key environmental conditions that select for particular behaviors and characteristics. This interaction, depicted in the top left circle in Figure 2, is nested within a larger interactive system involving the extent of the goodness of fit between the individual and his or her environments, including individuals' subjective appraisal of this fit in the light of their needs, goals, aspirations, and values; and both their reactive adaptation to any lack of fit, as well as their proactive problem solving based on their aspirations and values. In this particular rendition of the theory, a few of the key concepts from Piaget's developmental theory, involve accommodation, assimilation, and equilibration, are nested within this larger model to characterize strategies of reactive problem solving or

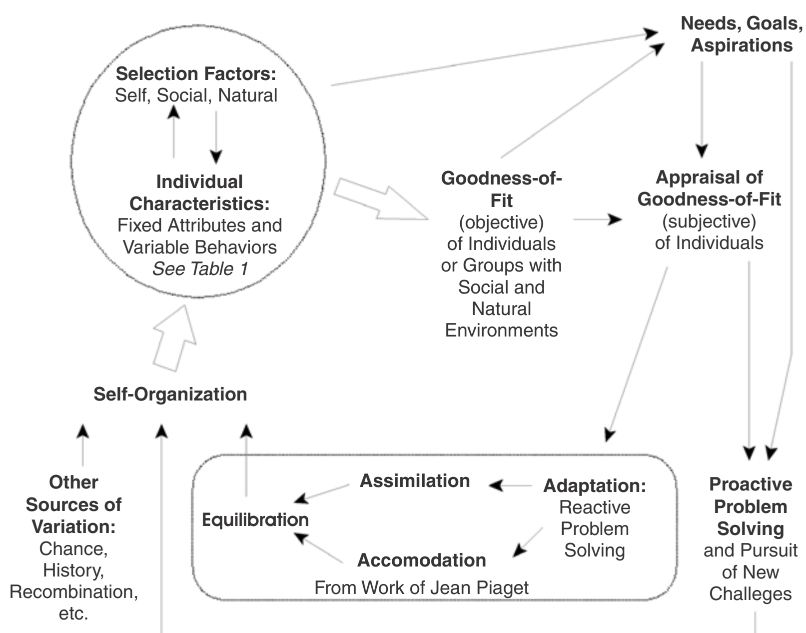
TABLE 1. Sources of Selection and Examples of Their Impact on Variations in Individual Characteristics and Behaviors

Variation/Selection		**Type of Selection**		
		Self	**Social**	**Natural**
Characteristics That Selection Acts on	**Social, Behavioral, Cultural**	• Commitment to a personal identity • Rejection of self based on behavioral or cultural stereotypes • Decisions of average students not to apply to the most competitive colleges	• Recruitment of individuals with outgoing personalities into various clubs or careers • Selection of human service processionals for positions based on their perceived interpersonal skills or their maturity • Greater likelihood for survival during wars of people who can cooperate with one another	• Survival of people in floods based on ability to swim • Survival during epidemics based on ability to maintain hygiene and to cooperate with one another • Increased chance for living a long life, based on exercise, social support, access to health care, etc.
	Physical, i.e., age, gender, race, height, etc.	• Decisions of individuals to undergo arduous migrations based on an assessment of their own health or strength • Tendency of many to select themselves out of certain career options based on their gender	• Exclusion of individuals from social opportunities based on sexism, racism, ageism, physical disability, etc. • Competition of strippers form jobs based on sexual attributes	• Survival of individuals with strong immune systems during epidemics • Better ability for heavier people to survive life in extremely cold conditions
	Note: Each of the above are illustrations of the impact of self, social, or natural selection on individual lives, specifically, on factors that enhance or detract from their well-being and survival, as well their support of other's well-being and survival.			

adaptation. The cumulative results of both reactive adaptive behavior and proactive problem solving are then self-organized, perhaps given a certain critical mass of activity, into new sets of characteristics, behaviors, and ultimately, new selective factors. The relationships portrayed in Figure 2 represent a few of the key ways that self, social, and natural selection are nested within the larger problem-solving are efforts of the individual and the ways that these are self-organized to create observed developmental patterns. It can be applied to understanding both transitions between developmental stages on the individual level, as well as inter-generational patterns and the development of larger systems such as families or communities within which individual development is nested.

It is proposed here that self-selection be considered as a central dynamic in conscious self-organizing systems. Self-selections, especially when they are repeatedly made and implemented, are the seeds for psychological and social self-organization, defining its boundaries, releasing the energy, establishing the operating rules, and providing the diversity that it thrives on. In short, self-selection tends to integrate, amplify, and perpetuate the effects of each of the preceding dynamics considered. When natural selection acts on a physical characteristic, the incremental results of this selection are perpetuated from one generation to another through the genetic code. The results of social selections

FIGURE 2. Development as an Outcome of the Multiple Effects of Selection, Adaptation, and Self-Organization: Some Key Relationships



Notes: The above reflects only a few of the important relationships between self, social, and natural selection; individual goals; reactive and proactive problem solving; and self-organization in human development. It is the iterative or repeated looping around this causal chain, both within lives and between generations, on the intrapsychic, personal, and group levels, that is expected to produce the developmental patterns we experience and observe.

are propagated through a variety of means, such as socialization and education. The propagation of changes stimulated by self-selection are supported not only by these means but also, in general, by power of autopoietic self-organizing systems to self-produce and self-replicate.

Self-Organization and Nonlocality. One of the difficulties with self-organization theory, as well as traditional systems theories, is that of accounting for how diverse and apparently simultaneous changes throughout a system are somehow integrated into a coherent pattern or structure. One of the fields where this has been a major stumbling block is the study of the neurological correlates of consciousness (NCC), and in this context, it has been referred to as the binding problem. For example, it is known that the brain has various specialized neurons that detect separate features of a visual scene, such as lines, colors, motion, corners, etc., and that some of these are in distant and poorly connected parts of the brain. However, in the milliseconds that it takes for this information to become conscious, it is experienced as an integrated perception. Traditional researchers suggest that complex feedback loops between these distant areas integrate the information. However, an increasing number of researchers have proposed various mechanisms that capitalize on the laws of quantum physics, specifically, nonlocality and superposition. These may also be central to understanding one type of self-organization, which will be referred to here as *nonlocal self-organization*. The traditional dynamics of self-organization, reviewed in previous sections, emphasize the operation of local activity rules in controlling the interactions of adjacent components of a system. This is a type of local or atomistic causation similar to the interaction of billiard balls. Nonlocality, regarded as a type of superposition, is a phenomenon in which "entangled" particles or other objects affect each other regardless of temporal or spatial distances or any conceivable local interaction.

Since the inception of quantum theory, nonlocal relationships between particles has been one of its central predictions. It was one that Einstein found particularly objectionable, calling it "spooky action at a distance." In a classic article by Einstein, Podolsky, and Rosen (1935), an experiment was proposed to test the prediction of nonlocality. Then in the 1960s, John Bell was acclaimed for his proposal for a design for an experimental test of nonlocality (1965), but it was not until 1982 that newly developed technologies permitted Bell's proposal to be implemented and nonlocality tested. Alain Aspect (1982) in Paris was the first of many to experimentally confirm nonlocality and at the same time disprove alternative explanations that hidden variables might be involved. Specifically, he examined the case of pairs of photons that become 'entangled' and then separated, yet retained an instantaneous ability to co-vary in their spin whatever their distance from one another, and with no possibility of any physical connection between them. A common interpretation is that when particles are entangled they are actually the same particle superposed and manifesting at different points in space-time. Nonlocality is now a well established phenomenon on the microphysical level; however, its relevance to macrophysical phenomenon remains controversial. A growing minority of quantum physicists contend it also exists on the macrolevel, creating multiple universes; however, most still believe it is confined to fairly delimited systems of particles and perhaps molecules. Nonlocality is sometimes regarded as a special case of superposition, or the tendency for quantum systems to assume multiple states (positions, charges, spins, etc.) simultaneously, and then under some yet to be defined conditions, a collapse, reduction, or selection to a single discrete reality happens in what is regarded as a completely undetermined manner. The phenomenon of the reduction or selection of superposed quantum states within the inner structure of neurons is a central feature of the Orch-OR theory of consciousness proposed by Stuart Hameroff and Roger Penrose (Hameroff, 1998; Penrose, 1995). Consciousness, they hypothesize, is the outcome of a pulsed collapse of superposed informational states within the micro-tubular structures within neurons. Each collapse is an undetermined act of quantum selection from multiple pre- and unconscious realities, and this, they suggest, may be the basis of free will. Nonlocality is reminiscent of C. G. Jung's Theory of Synchronicity (1973), in which he suggested that, in addition to the traditional forms of causation, some events are best understood as arising out of this "acausal connecting principle" that links separated events, involving both ideas and physical events. Even if it is assumed that nonlocality operates only at the microphysical level, several authors have suggested that such acausally linked microphysical events become amplified and stimulate larger scale events due to the now well understood "sensitivity to initial conditions" that is characteristic of many nonlinear systems. For example, Santinoyer (2001) contends that "We have thus proven that the human brain amplifies quantum effects into the scale of terrestrial life–at least certain human brains do" (p. 188). Thus, nonlocal self-organization may involve the parallel amplification of nonlocally linked microphysical events through a system creating a level of coherent and organized activity not achieveable through local interactions alone.

The role of quantum nonlocality and superposition in self-organizing systems such as the human brain, as well as larger social systems, has yet to be fully demonstrated, as much as there is evidence of its existence. While both local self-organization as well as nonlocality are well established in separated domains of inquiry, the possibility of nonlocal self-organization has been largely neglected by many self-organization theorists who have been slow to question some of the atomistic assumptions of the classical sciences. Yet, in social work with its larger concerns with conscious self-organizing systems of meaning and human relationships, this may be particularly needed.

Discussion. Although many human behavior theories and social work practice models have been based on systems theory, systems theory largely means general systems, an approach that has now been supplanted by complex systems theory. Of the many complex system theories now being developed, the theory of self-organization is perhaps the one most relevant to social work. The field has for years drawn on various equilibrium theories–whether general systems theory, ego psychology, structural-functionalism, or Piaget's genetic epistemology–that illuminate the sources of stability and continuity, but do little to clarify social and psychological change. For example, growth in Piaget's model originates exogenously when external conditions create disequilibrium that the individual then needs to react or adapt to. Our traditional theories rarely allow for inherent self-directed change, and thus, they assume that planned change and the helping relationships must induce these from without often through a carrot and stick approach. Prevailing social work values emphasize self-determination and engaging clients and systems in collaborative relationships, but unfortunately, these value commitments lack a sufficient theoretical foundation for understanding specifically how it is possible to achieve these things.

Self-organization theory has identified several important dynamic processes that clarify some of the sources of self-directed organizational activity; (1) the dissipative flow of energy and information through a proto-system stimulates activity and thus interaction among the component parts; (2) these interactions are then structured by evolving local activity rules; (3) which in certain instances bring about their structural coupling into larger units; (4) evidence suggests that when these rules and the subsequent coupling results in a balance between order and chaos, or the "edge of chaos" phenomenon; (5) that the system is then best able to capitalize on the random fluctuations and diversity within its boundaries, amplifying these into novel and often adaptive structures or behavioral patterns.

Self-organization theory, nonetheless, has its limitations. While it is free of some of the debilitating assumptions of the classical Newtonian paradigm, in other ways it perpetuates them. In particular, it minimizes the possibilities for any efficacious role for consciousness in complex adaptive systems, and furthermore, it relies excessively on notions of local causation. Supporting research is still in its formative stages and, as is the case in many fields, has lagged behind the theory. While simple or idealized systems can be modeled using approaches such as cellular automata, genetic algorithms, or system dynamics, often the collection of sufficiently well-developed real life data to test these models, with thousands of time points, is impractical. The statistical techniques for analyzing the simultaneous interactions of multiple units, levels of aggregation, variables, over multiple time periods, have yet to be developed. Cutting edge statistical methods typically address only two or three of the above needs, never all at the same time. Until such techniques can be developed and self-organization theories as a whole can be adequately tested, the concepts and metaphors of self-organization theory can be used in qualitative assessments of systems of concern. It is important to acknowledge the metaphorical level as an important *starting point* for this development. According to the philosopher of science, Max Black, most scientific models are "systematically developed metaphors" (cited in Barbour, 1974).

This article has identified several neglected dimensions that may be of particular relevance to the study of self-organization as it applies to human behavior and social systems, and thus, for the profession of social work. The role of consciousness, however it is defined, is perhaps the most obvious such dimension. To the extent that consciousness is regarded as merely a passive or reactive observer of the natural world, then this neglect may be understandable. However, if one takes the position that fundamental to consciousness is intentionality, and specifically choice, then the matter is complicated. Consciousness–whatever it is–would be then presumed to have an independent impact on the dynamics of some self-organizing systems, over and above the processes already discussed. Some of these impacts may involve its introduction of novelty, its integrative role, and its introduction of greater directionality. Much of the impact of consciousness can be examined in terms of the role of self-selection, the capacity for conscious systems to select from among possible perceptions, feelings, acts; to select preferred courses of action, prior to the admittedly substantial impact of social and natural selection. The concept of self-selection places human will in reciprocal relationship with the sources of external selection (both social and natural) which in many analyses are regarded as determinative.

The final neglected dimension identified in this article, nonlocality, introduces the application of quantum theory to understanding both the role of consciousness and self-selection in higher level self-organizing systems. Quantum mechanics has generally been regarded as the most consistently substantiated theory in the history of science, yet it is one that fundamentally departs from the classical paradigm involving complete predictability of physical world governed by local interactions, principles of non-contradiction, and absence of any impact of consciousness or observation on physical reality. It is proposed in this paper that while much self-organization is governed by local interactions between system parts, that at least higher level conscious systems also involve nonlocal self-organization, involving the idea that some of the amplifications of system noise or fluctuations involves the amplification of entangled nonlocal correlations, within the human brain, and perhaps within larger systems. Such parallel amplification may be one means by which systems achieve coherence, and in the case of consciousness, solve the binding problem. This is, however, a hypothesis that is yet to be tested.

Understanding self-organization, its preconditions, dynamics, and the ways that may be functional or dysfunctional, is a foundation for knowing when and how to intervene to facilitate, or even to control, such processes. Engaging clients, helping them to clarify their needs and goals, and establishing conditions for self-help, drawing on family and community support networks, are among the many social work values that are consistent with self-organization theory. However, self-organization theory suggests that attention be paid to the flow of "energy"–whether this involves enabling information, physical resources or money, or a sense of enthusiasm–through a system, and understanding rules governing the use of this energy. Such rules might involve unconscious assumptions people make about themselves or others, the norms for interacting, or formal rules and laws governing a community or policy system. The theory also suggests that the combination of the flow of energy and certain rules increase interactions among formerly isolated parts, leading to interdependency and structural coupling, which may involve helping as well as destructive relationships. If we are to draw on an expanded version of self-organization theory, as is suggested here, then top-down control processes need also to be observed for, and either strengthened or discouraged. Self-organization theory favors bottom-up strategies and suggests that the social work adage, "start where the client is at," is of particular importance, but it does not exclude top-down approaches or external intervention, for example, that might be needed in a child protection setting. If self-organizing processes are understood as sometimes including the dynamics of conscious self-selection, even that which is non-local, the approach may prove to be a particularly important part of social work's theoretical base. And it may be that one of the most potent conditions for self-organization are our self-selections, our dreams, and aspirations, especially those that are shared with others.

NOTE

1. Portions of this section and the following section on Dynamics are adapted from the author's earlier work: Hudson, C.G. (2000). From Social Darwinism to self-organization: Implications for Social Change Theory. *Social Service Review*, *74* (4), 533-559.

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