Occupational Science and Social Complexity

by

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Introduction

The science of complexity is in its infancy (Waldrop, 1992) and as diverse disciplines attempt to apply the tenets of complexity to their respective fields of knowledge, there is bound to be uncertainty and ambiguity (Lewis, 2000). This is evermore the case when facing social complexity. Occupational science is just beginning to consider humans as occupational beings from the perspective of complexity science. The efforts to date have focused their level of analysis upon the individual as a complex system (McLaughlin Gray, Kennedy, & Zemke, 1996a, 1996b; Persson, Erlandsson, Eklund, & Iwarsson, 2001; Royeen, 2003). Within these perspectives the symbolically rich aspects of social interaction are considered, though as environmental factors with which the individual interacts. This paper will explore social complexity in terms of person-to-person interaction; a system level of analysis with significant implications for the study of occupation. A review of investigations into group and community level social systems from diverse academic disciplines will elucidate contributions of complexity science to the contemporary study of social phenomena. The paper continues by demonstrating how the principles of social complexity, though not explicitly addressed by occupational science authors, are nonetheless evident in their study of occupation. Given that occupational science scholars have voiced an interest in exploring occupation as a social phenomenon (Larson & Zemke, 2003; Segal, 1999; Zemke & Clark, 1996), the discipline may be well positioned to engage in the interdisciplinary dialogue of social complexity.

Complexity in Brief

There are many definitions of the term complexity, many natural, artificial and abstract objects or networks can be classified as complex systems, thus making their study (complexity science) highly interdisciplinary (Waldrop, 1992). Examples of complex systems include: ant-hills, human economies, humans themselves, human biological systems such as the nervous system and immune system, telecommunication infrastructures, and social networks (Johnson, 2001; Lewin, 1992). A complex system is one whose component parts interact with sufficient intricacy that they cannot be predicted by standard linear equations. With so many variables at work in a system, its overall behavior can only be understood as an emergent consequence of the holistic sum of all the myriad behaviors embedded within the system (Marion, 1999). Complexity science suggests that the nonlinearity of the system gives rise to unsuspected richness and variety. From this complex and unsuspected behavior, patterns of order emerge which in turn influence the interaction of the agents within the system. The feedback from the system may exert significant influence on the behavior of the individuals, ultimately impacting their interaction and the dynamics of the entire system (Johnson, 2001).

Complexity science has arisen in part from studies of chaotic and dynamical systems to seek answers to some fundamental questions about living, adaptable, changeable systems. According to Waldrop (1992), the Santa Fe Institute played a significant role in the development of complexity science with the integration of a diverse array of academic disciplines, including computer science, artificial intelligence, economics, physics, materials engineering and ecology. The following characteristics are common to complex systems (Johnson, 2001; Lewin, 1992; Marion, 1999; Waldrop): 1) Relationships between components of the system are non-linear,

meaning that a small perturbation may lead to dramatically large effects. By contrast, in linear systems the effect is always directly proportional to a cause. 2) Local rules affecting the relationships between components of the system lead to the emergence of global system order; 3) Both negative (damping) and positive (amplifying) feedback are often found in complex systems. The effects of an element's behavior or the emergent behavior of the system are fed back in such a way that the element itself is altered. 4) Complex systems are usually open systems; they exchange some form of energy or information with their environment. 5) Complex systems are historical systems that change over time, and prior states may have an influence on present states. 6) The components of a complex system may themselves be complex systems. For example, an economy is made up of organizations, which are made up of people - all of which are complex systems. 7) Complex systems may exhibit behaviors that are emergent; they may have properties that can only be studied at a higher system level.

Complex adaptive systems are special cases of complex systems (Holland, 1995) which are adaptive in that they have the capacity to change and learn from experience. John Holland describes a complex adaptive system as a dynamic network of many agents (which may represent cells, species, individuals, firms, nations) acting in parallel, constantly acting and reacting to what the other agents are doing. The control of a complex adaptive system tends to be highly dispersed and decentralized. If there is to be any coherent behavior in the system, it has to arise from competition and cooperation among the agents themselves. The overall behavior of the system is the result of a huge number of decisions made every moment by many individual agents (Waldrop, 1992).

Complexity science has precipitated a significant shift in the approaches scientists have taken toward their problems (Suteanu, 2005) and can be understood as standing in opposition to

reductionism and determinism. Two definitions of reductionism have relevance for this discussion. Theoretical reductionism holds that all fields of knowledge can be reduced to one field of science. For example, physics has been considered as the basic science to which all other sciences can be reduced and of which they are extensions. Methodological reductionism suggests a method of exploration whereby large systems are iteratively broken into smaller systems until one finds a set of simple systems that can be understood and explained. Determinism suggests that every event has a cause, and given an understanding of an initial set of conditions, the outcome can be predicted (Angeles, 1981).

Complexity science eschews reductionism and determinism by focusing on the emergent properties of a system and the non-linear interactions of a system's components. Complexity science recognizes that such systems cannot be understood simply by understanding the parts - the interactions among the parts and the consequences of these interactions are equally significant. The concept represents the dynamic interactions of diverse agents who self-organize and produce adaptations that emerge in ways that can neither be predicted nor controlled (Lewin, 1992). Further, complexity science suggests that when given a relatively simple system which adheres to a few simple rules, the interactions of the components within the system give rise to immensely complicated and unpredictable outcomes (Waldrop, 1992) .

Byrne (1998) has suggested that complexity science can be framed within a realist epistemology. His position on realism suggests that what we observe in the world is real and the product of complex and contingent causal mechanisms which may not be directly accessible to us. Harvey and Reed (1997) have also adopted a realist ontology in their study of the dynamics of dissipative social systems. Dissipative social systems are ever evolving, based upon the collective action and interaction of their human constituents. The nature of a given system is

ultimately influenced by personal subjectivity and self-definition of personal actions. Byrne, as well as Harvey and Reed, acknowledge the necessity of a methodological pluralism for studying the dynamic nature of social systems. The authors acknowledge that a formal complexity-based social science will be established upon statistical modeling. However, they argue that the study of social systems will likely require qualitative forms of inquiry a basis for this mathematical modeling, necessitating interdisciplinary cooperation. It is in this light that complexity science should not be seen as supplanting established epistemologies, rather it should be recognized as a means of enhancing both methodological and theoretical approaches for exploring socially embedded phenomena (Eve, Horsfall, & Lee, 1997; Kiel & Elliot, 1997).

Complexity and Occupational Science

Complexity science was first introduced in detail within the occupational science literature as dynamic systems theory by McLaughlin Gray, Kennedy and Zemke (1996a; 1996b). As they discussed, dynamic systems represent systems that change with time and are characterized by complexity, randomness and nonlinearity. In the context of dynamic systems theory biological organisms are identified as complex, multidimensional systems that exhibit self-organizing properties. Explicit in their treatment of dynamic systems theory was the notion that a human as an occupational being represented a complex system, and it was this system level of analysis that was advocated for occupational science. In reinforcing their position, McLaughlin Gray and her colleagues (1996a) reviewed relevant applications of dynamic systems theory which addressed human motor development and language acquisition, with human behavior (occupational engagement) identified as the emergent property of the system. Recent

empirical evidence in occupational science has suggested that a focus upon the level of the human as a complex adaptive system, with occupational routines as emergent phenomenon, represents a useful application of dynamic systems theory. Jonsson, Borell, and Sadlo (2000) for example, studied 29 men and women over a period of seven years as they transitioned into retirement. Changes in the temporal rhythms and meanings of activity were observed to be a frequent occurrence. The authors framed these adaptive changes within aspects of dynamic systems theory such as system self-organization.

Additionally, Persson, Erlandsson, Eklund, and Iwarsson (2001) have developed a model which emphasizes the assigning of personal meaning to occupations throughout an individual's life course, a "repertoire of occupations," for which a dynamic systems perspective is required to appreciate its complexity. Occupational (activity) involvement is then posited to occur within a hierarchical nesting of increasing complexity. The most complex macro-level involves the full life course of an individual's occupations, the meso-level draws attention to a given occupation (e.g. having breakfast), while the micro-level involves the more minute actions (e.g. gripping a coffee cup). According to these authors the, "…hierarchies exist in the sense of smaller subsystems within larger systems, but all changes within and between subsystems are characterised by non-linear interactions" (p. 15). The model appears to be a useful heuristic which suggests that the personal meaning of any occupation can not be fully appreciated outside of a life course perspective.

Recent work by Ikiugu (2005) provides additional support for integrating a complexity perspective in the interpretation of occupational phenomena at the system level of the individual. In this study, nine university students completed daily occupational inventories reporting the type and frequency of their activities over a 21 day period. The students later ranked their

activities by degree of personal importance, and reported their reasons for these rankings, including: enjoy-ability, instrumentality, value placed on the occupation by a significant other, sense of accomplishment, and therapeutic importance. In interpreting the findings, Ikiugi suggested that the meaningfulness of the occupations could be best understood in terms of an occupational-life-trajectory, supporting the position of Persson et al. (2001). Ikuigi posited that the meaningfulness of the occupations and conditions which supported these meanings formed an attractor state, or basin of attraction. This attractor state could be interpreted as those life goals, values, and interests that imbue the activities with personal meaning.

Charlotte Brasic Royeen (2003) offered a somewhat different perspective of occupation in terms of chaos and dynamic systems theory in her Eleanor Clarke Slagle Lecture. Royeen referred to the complex interaction of three systems: 1) internal occupational process (the brain), occupational performance (the body), and occupational contexts (the environment) which in turn give rise to the emergence of occupation. In addition, Royeen hypothesized that a human's occupations are strung together into occupational patterns or processes that are, "in and of themselves, chaotic systems that are self-organizing, self-guided and, in states of health, far from equilibrium" (2003, p. 615). In this light, at one level of analysis the human is identified as a complex adaptive system from which occupational processes emerge. Occupations are then considered as agents interacting within their higher-order system. What is unclear in Royeen's theory as it relates to complexity theory is the manner by which occupational processes interact. Though she had offered an example of enfolded activities (i.e., when two or more occupational processes such as exercising and watching television occur simultaneously) to suggest interaction, this appeared to represent parallel rather than interacting tasks. A clearer example of the interaction of task can be found within the concept of personal project systems (e.g., Little,

1998, 2000). This perspective from personality psychology views individuals as ecologically embedded, having ongoing projects (akin to occupations) to which they allocate their time and resources, while engaged in an ongoing process of negotiating and prioritizing their activities so as to maximize well-being.

Consistent within the models presented by Persson et al. (2001) and Royeen (2003) are multi-leveled systems which are hypothesized to engender mutually influencing effects upon the enactment of occupation. The brain, the body (or behavior) and the environment reflect the hierarchical levels posited by Royeen, in addition to the interaction of discrete occupations. The model of Persson et al. explicates occupation from three interacting levels (micro, meso, and macro) embedded in a temporal life-trajectory of a person-task-environment complex. These models are generally consistent with other multi-leveled models which identify the person, the task or occupation, and the environment as the three key constituents of human occupational performance; see Crist, Royeen, and Schkade (2000) for a review. What is missing from these perspectives on environment and occupation, as well as that suggested by McLaughlin Gray, Kennedy and Zemke (1996b), are the complex dynamics inherent in the social and symbolic richness of human to human interaction. For example, given Ikuigi's (2005) findings of relatively stable states of occupational meaning in the individual, it would be reasonable to suggest that for certain occupations the attractor state for an individual has much to do with the people with whom the activity was performed. This position was argued by Kelly (1978) who found that personally meaningful activities were often described in terms of engagement with significant others. Related to this, Unruh (1983) has suggested that a deepened personal investment in socially mediated occupation is frequently a function of not only personal interest, but also of the affordances and receptivity of a particular social world. Might occupational

science inquiry elucidate the mediating functions that occupations serve in linking individuals to social collectives as suggested by a social complexity perspective?

Application of the tenets of complexity theory at the level of the human as a dynamic system by occupational scientists represents a fruitful endeavor (Royeen, 2003). These important contributions are clearly in line with the mission of occupational science in developing a greater appreciation of the human as an occupational being (Yerxa, 2000). As well, occupational science seeks to generate knowledge about the form, function and meaning of human occupation (Zemke & Clark, 1996), and given the likely emergence of relatively stable occupational states from the complex human system, future efforts directed at this level of analysis are surely warranted. But what might be gained if occupational scientists expand their views to incorporate social levels of complexity? What characteristics of occupation might be illuminated when complexity phenomenon such as networks of interpersonal interactions or emergent local cultural beliefs begin to influence occupational science epistemology?

The Individual as Agent in Complex Adaptive Systems

When an individual is conceptualized as an agent interacting with other agents within a complex adaptive system, one again can apply the tenets of complexity theory to this level of analysis (Nowak & Vallacher, 1998). From the interactions of these individuals, emergent phenomenon such as patterns of collective behavior (Lewin & Regine, 2000) and shared values and beliefs (Wenger, 1998) may become evident. Further, with one property of complex adaptive systems being the feedback of this emergent phenomenon back onto the human agents, we can start to conceptualize how the formation of a shared belief system may influence the

behaviors (occupations) of the individuals within that system. This perspective of the individual as an agent within a complex adaptive system will serve as the focal point for the remainder of the paper.

Conceptualizing individuals as agents within a complex adaptive system does not negate the importance of considering them as complex adaptive systems in and of themselves. An initial understanding of any complex system is premised upon a reasonable appreciation of the individual agents (Holland, 1995). Further, social systems theories typically hold that one level of analysis cannot be fully appreciated without insight into the levels of analysis which precede or follow one's level of interest (e.g., Egan, 1984; Harvey & Reed, 1997). For example, should the family be the level of interest, a process of family-focused intervention may benefit from a greater appreciation of each individual within that family, as well as the local cultural and societal factors with which the family may be dealing (Spronk & Compernolle, 1997). One could even expand upon these levels of analyses, such as identifying a biologically based issue that might be influencing a particular family member (e.g., acquired brain injury), as well as a state or national concern that may be impacting local societal dynamics (e.g., limited access to affordable health care).

Complexity theory recognizes that social systems may be differentiated based upon varying levels of analysis (Lee, 1997). Complex adaptive systems are composed of agents that interact with, and mutually affect the other, and in doing so generate novel behavior for the system as a whole. The interactions among the agents in the system are of particular interest, leading to complex and unpredictable outcomes though ordered patterns likely emerge. These patterns may then serve to mediate the interactions of the agents within the system. Within business organizations, for example, how individuals interact and the patterns of relationships

that develop has everything to do with the type of culture that emerges (Lewin & Regine, 2000). In turn, this emergent culture may influence the manner in which one approaches one's job responsibilities, likely altering the personal meaning one ascribes to work.

Inevitably, as the level of analysis is shifted away from the individual more attention will be focused upon the dynamic interactions between group members. The interests of the researcher may be patterns of everyday routines among individuals (Gallimore & Lopez, 2002), or the manner with which individuals maintain cohesive social ties (Nowak & Vallacher, 1998), as well as the shared (or discrepant) beliefs and values that surface when individuals are engaged in mutual practice within a community (Lave & Wenger, 1991; Wenger, 1998). The preceding examples imply that the richness of social interactions may yield a different perspective on the human as an occupational being. Though a social level of analysis may restrict the attention given to any one individual, the resultant understanding of the manner by which individuals mutually influence each other through shared occupations would likely extend our views of the form, function and meaning of human occupation. Such an understanding is already being sought in terms of parent-infant playfulness (Holloway, 1997), family experiences of disability (Mattingly & Lawlor, 1998), and shared community endeavors (Christiansen & Townsend, 2004; Frank, 2007). Scholars in occupational science have advocated for the elucidation of the social construction of occupation (Larson & Zemke, 2003; Segal, 1999; Zemke & Clark, 1996). A social complexity perspective emphasizing person-to-person interaction will likely afford occupational science additional theoretical space within which to explore the dynamic nature of occupation.

Complexity Principles and the Dynamics of Social Systems

Capra (1996) has suggested that human societies present a significant challenge to the application of complexity theory because of the crucial role of language, which has been critical in the development of consciousness and culture. Capra posited that because of the 'inner world' of concepts, ideas, and symbols that arise with human thought, consciousness and language, human social systems exist not only in the physical domain but in the symbolic social domain as well. Similarly, Stewart (2001) has argued that social processes and phenomena give rise to far too many particularities for complexity theory to genuinely elucidate at the level of society, and that the nature of complexity, and especially social complexity is very open to debate and further research. Further, Stewart advised that transposing mathematical or biological models of complexity to various institutions and social processes presents a significant problem for researchers and philosophers alike.

However, despite the apparent pessimism suggested by these authors, there is also a strong sense of optimism that this task, as it is inevitably taken on, will provide important insights into the nature of social relationships. For instance, Marion (1999) has suggested that complexity theory will be useful for describing numerous aspects of social dynamics. She argues that the outcomes of social systems may not typically be predetermined, yet a sense of predictability and stability is quite likely, as the emergence of educational movements, organizational climate, cultural memes and technologies could be reasonably described by complexity science. Kiel and Elliot (1997) have embraced complexity science as a research tool sensitive to the historical and temporal nature of social systems. Their text draws upon complexity research with established

applications in the fields of economics and political science, and highlights how complexity science will be useful for enhancing both the methodological and theoretical foundations for exploring the dynamic nature of social phenomena. Further, Harvey and Reed (1997) acknowledge the 'wild card' aspect of human action and subjectivity, and posit that this aspect of human nature can be modeled within dissipative social systems. Notably, they implore researchers to remain open to utilizing a range of methodologies which best capture the ontological nature of their subject matter. Finally, Byrne (1998) has asserted that as a basis for social action:

> Complexity/chaos offers the possibility of an engaged science not founded in pride, in the assertion of an absolute knowledge as the basis for social programmes, but rather in a humility about the complexity of the world coupled with a hopeful belief in the potential of human beings for doing something about it. (p. 45)

The pursuit of applying complexity theories to the vagaries of social dynamics will entail the cooperation of a contingent of interdisciplinary perspectives (Lansing, 2003; Stewart, 2001). Though mathematical models are deemed essential in moving beyond a mere metaphorical application of complexity (Nowak & Vallacher, 1998), the particularities inherent in human language, symbolocity, emotion, and action might at first be more effectively captured through means of qualitative inquiry such as narrative (Lewin & Regine, 2000), hermeneutics and phenomenology (Stewart, 2001; Williams & Austin, 1998), as well as ethnography (Marion & Uhl-Bien, 2001). Occupational science has been founded upon the understanding that interdisciplinary cooperation will be an essential approach in the study of occupation. Further, occupational scientists have held that qualitative methods provide a rich understanding of human

occupation, as apposed to more reductionistic modes of inquiry. From this perspective, occupational science may be well positioned to enter into the interdisciplinary dialogue of social complexity. Such inquiry would inevitably generate models of occupation inherently sensitive to both intra-individual and inter-individual dynamics.

Efforts are already underway across a number of disciplines which may provide some guidance to interested occupational scientists as they consider the application of complexity theory to the level of the social group. There are a number of important texts which have begun to explore the application of chaos and complexity to the social sciences in general (Byrne, 1998; Kiel & Elliot, 1997; Marion, 1999) and sociology specifically (Eve et al., 1997). Research conducted in the fields of anthropology, sociology and the area of group studies provides a useful glimpse into the application of complexity science to social systems. First, an anthropological investigation hypothesized that the complexity principle of bottom-up organization was evidenced in Balinese farming practices that led to the development of complex irrigation networks supporting multiple communities (Lansing, 2003). It was argued by the author that irrigation networks linking multiple villages over great expanses of land emerged solely through the cooperation of local farmers. Farmers typically met only with local neighbors and there existed no comprehensive design plan as the irrigation system was laid out over generations. In turn, the irrigation networks influenced the seasonal farming practices of the farmers, ultimately impacting the temporal flow of activities. Second, findings from a sociological investigation suggested that the formation of cohesive interpersonal networks among a group of 16 women in a southern United States social club helped to explain the emergent pattern of their planned social events (White, Owen-Smith, Moody, & Powell, 2004). These authors reviewed 1930s data of attendance and activity records from the society-page of a local paper covering a nine-

month period. The evolution of each activity could be modeled as a function of the cohesion (frequency and consistency of interaction) among the members involved in planning their respective activities. The cohesion between the members was seen as emergent phenomena of interpersonal interactions, and the occupations of planning each activity served as vital nodes connecting the group members. Finally, a study within the area of group research investigated the verbal interactions among persons belonging to 16 work groups representing either not-for profit, educational, or social service organizations (Wheelan & Williams, 2003). Investigators coded participant statements in terms of group development categories (e.g., statements of fight, flight, pairing, dependency, work orientation). The codes were then entered into a computer which provided for a temporally ordered visual representation of the participants work statements within each group. Distinct visual patterns emerged from this analysis, by which the investigators could assign the groups to four pattern categories. In turn, the differences between group patterns reflected statistically significant differences in work statements, and the investigators were able to correspondingly assign groups to a scale reflecting their level of work productivity.

From these three examples, one may begin to identify a few tenets of complexity theory that appear to apply to the level of the social group: 1) the emergence of patterns of behavior at the group level cannot be understood at the level of any one individual (agent), 2) the emergence of relatively simple group patterns influence individual behavior and agent interactions, and 3) the manner of interaction between the agents (e.g., the level of cohesion) relates to the emergence of group specific patterns. Given these findings, occupational science might consider applying complexity theory to group level dynamics that are germane to its interests and history. Though the studies outlined above merely hint at potential research questions, it should be

apparent that an application of complexity theory focused at the level of the group may offer the field additional insights into the nature of occupation beyond what might be expected when our gaze is directed solely at the level of the individual.

In proceeding with this work, a useful text that reviews complexity theory applied to the field of social psychology offers a shared treatment of both the dynamics at the level of the individual, as well as that of interpersonal interaction, while considering the potential for the bidirectional influences of one level upon the other (Nowak & Vallacher, 1998). The authors have suggested that emergence, when considered in the light of both individual and collective levels of analysis, though having distinct qualities, may also have similarities that are unique within human dynamical systems:

> The elements at different levels of analysis may be related to each other in two ways. First of all, each element on the higher level may represent a collection of elements on the lower level. Thus, neural assemblies each represent a set of individual neurons, a social group represents a collective of individuals, and so forth. In this type of hierarchy, the elements at different levels may be described with respect to the same variables. One can therefore talk about the political attitudes of an individual and the political attitudes of a social group. (p. 253)

Further, it would be reasonable to suggest that the purposes and goals of a group may be congruent with, if not quite similar to, the purposes and goals of one of more given individuals within that group. The conceptual framework of Hill, Fonagy, Safier, and Sargent (2003), in their ecological perspective on attachment processes in family systems, is one example of this perspective. Their position is founded in the link between a shared interpretive frame engendered throughout the family and the experience and expression of individuality. The idea

of a ‘shared frame’ was defined as the collective manner with which the family members interpret actions, events, and the meanings of expressed emotions. From this frame, an individual’s goal directed action could be interpreted as a component of a joint-goal when a shared frame had been established. However, an application of perspectives such as these will need to bear in mind that dynamics within the individual are different from those of the group, and each level of description will require a specific theoretical language and set of research tools (Lee, 1997; Nowak & Vallacher, 1998).

Further uses of complexity principles may be found in the business and management literature. Innes and Booher (1999), for instance, have related consensus building to the inter-individual dynamics of group interaction, offering an account of how shared agreements and understanding might become known among individuals with differing perspectives and agendas. McDaniel, Jordon and Fleeman (2003) have used complexity principles in building a dynamical viewpoint to account for management practices within healthcare systems. Incorporating terms such as trajectories, bifurcations and self-organization, these authors have proffered a unique management perspective built on expressions found in the complexity literature. In a similar vein Marion and Uhl-Bien (2001) have developed a causal model to account for changes in attitudes following group or “aggregate” interactions. According to these authors, further applications of complexity science to business and leadership literature could spark theoretical innovation in areas of social capital, relational exchange in small groups, self-leadership, personal and group empowerment.

As well, business studies have begun to utilize qualitative methods in order to provide a richer understanding of the interindividual dynamics within organizational systems. Lewin and Regine (2000) employed narrative analysis to the transcripts generated from individual and

group interviews. In applying a complexity lens to the narratives, the authors produced a compelling analysis of small and large businesses as complex adaptive systems. Their findings reinforced an understanding that businesses are composed of a diversity of agents who interact with each other, mutually affect each other, and in doing so generate novel behavior for the system as a whole. According to the authors, the interactions among the agents (people) in a system led to complex and unpredictable outcomes, and it was these relationships that served as an organizing principle for these businesses. Additionally, the emergence of shared cultures, purposes and beliefs provided a source of feedback that influenced each individual's 'way of being,' as evidenced in shifting relational practices.

Finally, the disciplines of social work, nursing and education have begun to identify complexity science as a framework for studying complex human systems. Warren, Franklin and Streeter (1998) provide a readable overview of basic concepts from chaos and complexity, as they advocate for the application of these ideas across a wide range of social science disciplines. They compare and contrast the use of systems theories to complexity theories in social work, highlighting the capacity of the later to provide far deeper and nuanced understandings of the ways in which human systems arise and change. Additionally, Holden (2005) argued that health care systems should be studied as complex adaptive systems, as this analysis would afford healthcare leaders opportunities to enhance patient care outcomes. Anderson, Issel, and McDaniel (2003) adopted a similar view and provided empirical evidence in support of this position. Their study measured communication openness and participation in decision-making, among other variables, and correlated these with nursing home resident outcomes such as fractures and restraint use. The findings supported the hypothesis that management practices that facilitate self-organization contribute to better resident outcomes. Finally, Davis and Sumara

(2005) have suggested that complexity science is well suited to educational researchers in their ongoing efforts to understand how one might make effective interventions in systems that do not always change in predictable ways.

In summary, the preceding section has reviewed research into group level interactions from such diverse fields as sociology, anthropology, social psychology, group and organizational studies. These works were chosen to reflect varied perspectives from which common themes could be found to arise. A consistent position from members of these fields appears to be a growing appreciation for the usefulness of complexity theory in describing the dynamics by which individuals interact. The studies provide a snapshot into the potential influence of interindividual relations in their role of generating unique phenomenon at the level of the group. Though this level of analysis does not take into account a full understanding of the individual as a complex adaptive system, the above review does suggest that not only are an individual's occupations likely influenced through inter-agent dynamics, but also that emergent phenomenon at the group level mediates a shift in interindividual practices, which in turn influence the occupations of the person.

Socially Constructed Occupation and Complexity Science

Within the field of occupational therapy, Lawlor (2003) has suggested that the study of childhood occupations should be reframed as the study of "socially occupied beings." According to Lawlor, this perspective advocates for the, "conceptual understandings of the interconnectedness of social relatedness, intersubjectivity, social action, and engagement" (p. 424). This view of occupation is directed at the level of person-to-person interaction. That is,

rather than appreciating occupation as emanating solely from any one individual, occupation also may be viewed as a co-constructed phenomenon of mutually engaged individuals. Additionally, Lawlor promoted theoretical and research models capable of capturing the essence of socially occupied persons "*doing something* with *someone* else that *matters*" (p. 432). A number of occupational scientists and occupational therapists have also asserted their hopes for such an understanding. Zemke and Clark (1996) indicated that the study of occupation should be expanded in order to explore its social nature. They suggested the need for a greater understanding of the co-occupations of a mother and infant that would respect the active nature of each individual. Segal (1999) called for the study of group occupations as a separate phenomenon in occupational science. Her work with families with children with special needs highlights the complexities of human occupation and interaction as individuals within the family negotiate their mutual participation. In addition, Humphry (2005) has argued for the importance of incorporating a multi-leveled perspective of human development. While the main focus of the model she proffers is directed at the developmental trajectory of the individual, a significant cornerstone of the model lies in the influence of social transactions via shared occupations. Finally, Larson and Zemke (2003) provide a compelling article which draws one to consider the ontology of occupation from the perspective of person-to-person interactions.

A unique congruence exists between these calls for the study of occupation as socially constructed phenomena and the applications of complexity science to social systems. Insight into the patterns of social collectives (e.g. an institution, organization or family) will require a greater understanding of the nature of person-to-person interactions at the local or micro-context level. Lee (1997) has called for the development of theories and methods in the social sciences which explore social complexity at this level. Critical view points may come from the first

system of social interaction of which any person is a part – infant-caregiver interactions (Smith, 1997). The study of occupations as a socially constructed phenomenon should offer a rich framework within which to explore the dynamics of social complexity. There has been a tendency on the part of theorists of occupation to direct the application of dynamic systems or chaotic systems to the level of the individual (Ikiugu, 2005; McLaughlin Gray et al., 1996b; Persson et al., 2001; Royeen, 2003). However, as suggested in the bulk of this review, shifting the gaze to the level of the group, such that person-to-person interactions become one of a number of key aspects of study, might afford occupational scientists an additional perspective on occupation and social complexity.

Dynamics of Social Complexity within Occupational Science Literature

The principles of social complexity may not be immediately apparent within occupational science literature, requiring a means by which to bring their expression into relief. Furthermore, ascribing the tenets of complexity to descriptions of occupation is an important initial step in moving towards a social complexity perspective of occupation. Byrne (1998) has referred to this approach as "hearing echoes" (p. 10) of complexity in the written accounts of social reality, without explicit references to complexity having been made by the authors. Interestingly, there have already been empirical contributions in the occupational science literature that have explored some of these phenomena.

Primeau (2000) studied the occupations of families as they were engaged in housework and child care, with the understanding that parents must create and maintain sustainable, meaningful routines. Using a qualitative, multiple methods approach she identified three types

of child care routines typically engaged in by the parents. The first was 'shared routines' which referred to child care that incorporated a similar manner of approach, irrespective of the parent involved. 'Synchronized child care', the second type of routine, referred to the ongoing negotiation and sharing of child care responsibilities that occurred in a simultaneous and/or reciprocal manner. Lastly, 'separate routines' were identified when parents provided child care according to each parents' unique contributing routine, such that each child's occupational experience was structured at the discretion of the respective parents approach. From the perspective of complexity science, these differing routines may be considered emergent phenomenon (Mihata, 1997). They represent occupations temporally structured in response to the person-to-person interactions, while the existence of the routines cannot be explained in terms of any one individual. Further, each of the three child-care routines constitute attractor states for the routines. Attractor states may be understood as the sustained existence of a behavior along its particular trajectory (Marion, 1999; Nicolis & Prigogine, 1989). Therefore, the childcare routines described by Primeau appear to manifest two principles from complexity science.

Segal (1999; 2004) has studied the occupational routines of families with children either with or without special needs. The author discerned three purposes the parents tend to have in mind as they engaged their children in recurring patterns of occupation (Segal, 1999). These purposes: being together, sharing, and providing learning opportunities, supported the crafting of shared occupational opportunities and served to socialize the children to socio-cultural and familial values. Opportunities for sharing stories of their day, as an example, were undertaken in consistent occupations (e.g., dinnertime) on a recurring basis. Children understood that they were to behave in a manner that supported this sharing. Parental directives and the routine

nature of the activity over time apparently led to a mutual understanding of how each person was to behave during the sharing aspect of the occupation. From a complexity perspective, this occupation appeared to serve as a node for the communication of information among the members of the group. According to Holland (1995) the nodes of a complex adaptive system mediate the exchange of information, ultimately influencing the interactions of the agents and the behavior of a system as whole. It would be feasible to suggest that the sharing occupation served to communicate the expectations of the parents regarding how each child should behave. Also, the parents' values and beliefs regarding how a family should be organized and function were exchanged with their children via this occupation. This example further highlights the utility of viewing occupation from the perspective of social complexity as the open flow of information within a system is a vital aspect of its functioning. Segal's work suggests that occupations serve a critical function in mediating the exchange of information amongst family members.

Segal (2004) had found that family occupations may range from highly effective routine engagement to the fits and starts of a disrupted or non-existent routine. An effective familial routine would entail a smooth flow of occupations across time and space among all the family members so as to achieve the intended goals for each individual. Segal reported that for one family, one child was inconsistent in getting out of bed during the morning routine. The common response required one or the other parent to disrupt their routine to facilitate getting this child ready for the bus, otherwise resulting in a further disruption of the morning routines. The lack of a developed routine for this child was directly related to the disrupted routines of the parents. The entwining of the son and parent(s) routines could be related to the concept of cohesion (White et al., 2004). From a social networks perspective (Degenne & Forsé, 1999), high cohesion between members of a group will tend to bind the group closely in some manner.

In the example provided above, the tight cohesion between parent and child resulted in a disruption of the routine of the parent. Should the parent have had routines deeply entwined with other members of the family, this one disruption may have reverberated though the entire family as a function of the cohesion held between the parent and the other family members. Segal's work on family occupational routines again highlights how the study of occupation can inform the study of social complexity.

Where to now?

Complexity science has much to do with the interrelatedness and interdependence of components, their freedom to interact, align and organize, with dramatic implications for system change and adaptation. A number of fields in the social sciences are poised to explore their core constructs from the perspective of complexity science. In occupational science, the tenets of complexity are well suited to understanding an individual as a complex adaptive system with occupations arising as irreducible aspects of one's life-world. Adopting a social complexity perspective in occupational science will necessitate an expansion of this viewpoint wherein individuals are interacting and mutually influencing each other. Therefore, at this level of analysis the study of the form, function and meaning of occupation may shift to elucidate its inherent social dynamics. Should the discipline of occupational science pursue the study of occupation from this vantage point, it would be well situated to engage in the ongoing interdisciplinary dialogue of social complexity.

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