ULUSLARARASI SOSYAL ARAŞTIRMALAR DERGİSİ
THE JOURNAL OF INTERNATIONAL SOCIAL RESEARCH

Uluslararası Sosyal Araştırmalar Dergisi/The Journal of International Social Research
Cilt: 16 Sayı: 97 Şubat 2023 & Volume: 16 Issue: 97 February 2023
Received: February 03, 2023, Manuscript No. jisr-23-89510; Editor assigned: February 06, 2023, PreQC No. jisr-23-89510 (PQ); Reviewed: February 20, 2023, QC No. jisr-23-89510; Revised: February 24, 2023, Manuscript No. jisr-23-89510 (R); Published: February 28, 2023, DOI: 10.17719/jisr.2023. 89510
www.sosyalarastirmalar.com ISSN: 1307-9581

SOCIAL THEORY ARCHAEOLOGY: POSTPROCESSUALISM AND FEMINIST THEORY

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ABSTRACT

Post-processual archaeology, which is sometimes alternately referred to as the interpretative archaeologies by its adherents, is a movement in archaeological theory that emphasizes the subjectivity of archaeological interpretations. Despite having a vague series of similarities, post-processualism consists of very diverse strands of thought coalesced into a loose cluster of traditions. Within the post-processualist movement, a wide variety of theoretical viewpoints have been embraced, including structuralism and Neo-Marxism, as have a variety of different archaeological techniques, such as phenomenology.

INTRODUCTION

Nonlinear systems theory has transformed the dominant scientific paradigm in ways that have deep implications for archaeological theory and method. Nonlinear systems theory demonstrates that current archaeological analysis of patterns and processes is incomplete and so partial that our understanding of culture and cultural processes, especially evolution, is seriously compromised. The prevalence of nonlinear patterns and processes in culture and nature needs to be addressed by further development of archaeological theory and method. Comparison of nonlinear systems theory, feminist theory, and post-processual archaeology leads to suggested synergies, expansions, and areas of potential synthesis among

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these theoretical approaches. This paper explores the insights that nonlinear systems theory can contribute to archaeological theory and method. Dynamical nonlinear systems theory, chaos theory, and complexity theory are first defined, and their interrelationships are discussed. Then, chaotic processes are described and exemplified in processes relevant to archaeology. Some applications of nonlinear systems theory in archaeology are briefly reviewed. Next, it is argued that culture is a nonlinear system. Finally, an exploration of similarities, differences, and relationships between nonlinear systems theory, feminist theory, and post-processual archaeology leads to suggestions for expansions and synergies among these theories.

Paradigms limit the patterns and processes we can perceive and analyze from data. Nonlinear systems theory is a new scientific paradigm that developed out of the realization that apparently random variation can shape the irreversible evolutionary paths of complex systems. The recognition and analysis of chaotic systems and processes were not possible in the traditional scientific paradigm because it focused on regular recurring patterns and disregarded irregular variation as insignificant random noise. Nonlinear systems theory involves some fundamental changes in normative scientific assumptions, theory, and methodology that have been widely adopted in archaeology. The terms of dynamical nonlinear systems theory, dynamical systems theory, complexity theory, and chaos theory have often been used interchangeably, but they have been differentiated. Nonlinear systems theory is a paradigm in science that permits more accurate description and explanation of the evolution of most natural and cultural systems, patterns, and processes. This is because most systems are nonlinear to some extent. Nonlinear systems theory encompasses the other theories, which address particular aspects of nonlinear systems. A dynamical system is a mathematical model of the time-varying behavior, or evolution, of an actual system. Chaos and complexity are different but related kinds of behavior exhibited by nonlinear systems. Complexity theory is concerned with complicated systems and processes that are not quite chaotic but are on the edge of chaos. Complexity and chaos both combine orderly and apparently stochastic elements, but complexity is more orderly than chaos. In chaotic systems and processes, deterministic and apparently stochastic behaviors are interrelated, both being essential for the operation of a system or process. The hallmark of chaotic processes is that a small change within the system can lead relatively rapidly to a major change in the direction of the entire system.

Chaotic systems are called "sensitive to initial conditions" because they can rapidly amplify small-scale apparently random perturbations into large-scale changes in the direction of evolution of the system. Further, the significant small-scale changes are generated deterministically by and within the system and do not require external stimulus. Nonlinear systems and processes are defined by their potential to become chaotic. Chaos was technically defined at the 1986 International Conference on Chaos by the

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Royal Society in London, as stochastic behavior occurring in a deterministic system. In layman's terms, this means that disorder can be produced in an orderly system. Within the classical scientific paradigm this is a paradox. The evolution of a deterministic system is in principle completely predictable, determined by knowledge of the parameters that describe the system, its time-evolution equations, and its initial conditions. The evolution of chaotic systems cannot be predicted because the initial conditions cannot be accurately measured, and extremely small differences in initial conditions lead relatively rapidly to wide divergence in the evolutionary path of the system. Thus, the system has path dependence on the initial conditions. Chaos theory focuses on qualitative analysis of nonlinear behavior that is unstable and aperiodic. Unstable systems never settle into a stable state that resists small perturbations. In aperiodic behavior no system variables ever repeat the same values, resulting in an irreversible evolution of the system. Unstable aperiodic behavior cannot be predicted because it never repeats and is more sensitive to small perturbations that our instruments can measure. Unstable aperiodic behavior appears random when measured. History is a prime example of an unstable aperiodic process because it never repeats precisely and small, even individual changes can lead to a major change in the evolution of a culture and society. Perhaps the clearest example of an unpredictable chaotic system is the weather. In fact, modern chaos theory developed out of Lorenz's attempts to model the weather, which revealed how unmeasurably small differences in initial conditions led relatively rapidly to large divergences in the evolution of the weather system. Lorenz distinguishes between chaotic systems and nonlinear systems. While all chaotic systems are nonlinear, not all nonlinear systems are chaotic. Both are sensitive to initial conditions, but nonlinear systems may converge on an earlier stable state after a perturbation, while chaotic systems do not. Thus, the evolution of nonlinear systems may repeat a state and therefore be reversible in some sense, while chaotic systems never repeat a previous state and evolve irreversibly. In sum, all chaotic systems are nonlinear, but not all nonlinear systems develop chaos, although they have the potential to do so. The characteristics of chaotic systems are captured in the definition of chaos theory as "the qualitative study of unstable aperiodic behavior in deterministic nonlinear dynamical systems. This definition captures the paradox that complex apparently random behavior can be found in relatively simple deterministic systems. Nonlinear differential equations model the evolution of the most common types of dynamical systems, differentiable ones, in which the variables analyzed change in a smooth or continuous fashion. The evolution of differentiable systems is modeled with nonlinear differential equations called the "evolution equations" that specify the rules controlling the changing states of the system, such as rates of change in variables controlling the spread of disease. Nonlinear differential equations are named for including nonlinear mathematical terms for rates of change. Differential

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equations create a qualitative description of the long-term behavior of a system in general rather than making precise numerical predictions of future system state.

NONLINEAR PROCESSES RELEVANT TO ARCHAEOLOGY

Archaeology includes applications of nonlinear systems theory, including complexity and chaos theories. Complex and chaotic systems evolve through nonlinear processes, including endogenous oscillation, sensitivity to initial conditions, iteration, positive feedback, negative feedback, bifurcations, diffusion, dissipation, and self-organization. Chaotic systems endogenously create internal small oscillations. Then the system responds to the small-scale internal variations called initial conditions. Nonlinear systems' evolutionary paths are dependent on initial conditions. A system can rapidly evolve or diverge from a stable state through the interaction of nonlinear processes. Nonlinear systems fundamentally evolve through iteration, in which the same mathematical operations are repeatedly performed on each system state to create the next state in an evolutionary trajectory. The previous state of the system becomes input that is operated on by a combination of positive and negative feedback to create the next state of the system. The simplest example is a population system, in which the survival rate is the rate of iteration. Survival rate is a combination of the positive feedback of exponential birthrate, and negative feedbacks that dampen population growth through disease, starvation, war, infertility and other nonlinear processes. It is iteration that makes systems so sensitive to perturbations that they cannot be measured accurately enough to predict the resulting evolutionary trajectories. Rapid iteration of a small perturbation can quickly lead to a bifurcation or branching off of the system in a new evolutionary direction. Nonlinear evolution through positive feedback can produce oscillation or dispersion among a number of system states, or attractors. An attractor is a state to which a system is drawn or attracted. In a stable state, a system oscillates in a basin centered around a single point that is called a fixed point attractor. A system such as a population may oscillate between two different size states in what is called a limit cycle, or limit cycle attractor. Chaotic patterns and processes often have fragmented attractors called strange attractors in which a number of different states are simultaneously attractive, creating a fragmented pattern in the system, exemplified by water turbulence in a stream with a number of rocks that create eddies.

THEORIZING CULTURE AS A CHAOTIC SYSTEM

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This section theorizes that culture meets the criteria of a nonlinear system. This means that cultural systems have the potential for chaos and other nonlinear processes and patterns. Some nonlinear cultural processes have already been discussed. Nonlinear systems theory provides a coherent framework that interrelates a number of nonlinear cultural characteristics and processes and also relates them to linear processes. All of the below criteria involved in the identification of chaotic systems and processes are interrelated. First, culture is a nonlinear system because it is complex, dissipative, and self-organizing. Cultures use a number of processes in subsistence and manufacturing to prevent dissipation into entropy by self-organizing to gain inputs of energy from the natural environment and transform them into culture-sustaining products.

Second, many processes in cultural systems are too complex, discontinuous, and irregular to be accurately described or completely predicted from linear relationships among orderly variables, such as correlations or regressions. Chaotic systems and processes cannot be described and explained with linear cause and effect relationships, in which small changes produce small effects and large-scale causes are required to produce large-scale effects. Third, many cultural processes can be modeled with the nonlinear differential equations that describe the behavior of chaotic systems. These equations, analogous to the laws and rules of culture, produce both "chaotic" variation and more orderly patterns that are interrelated in cultural processes. Therefore, disorderly variation is information that cannot be ignored without loss in accuracy of description and explanation. Culture meets a fourth criterion of a chaotic system, because it is often sensitive to initial conditions. This means that initial small scale, even individual variations in culture or environment, can lead to large-scale changes in the direction of cultural evolution. A small change in one variable can have a disproportionate impact on other variables. Small-scale perturbations are more likely to be amplified into major cultural change in unstable cultures. The combination of chaotic and orderly elements in culture often creates some degree of cultural instability. However, since cultures are open systems they have the potential for sensitivity to initial conditions even in stable states. Small-scale variations produce large-scale change through nonlinear processes such as positive feedback and iteration. This process is exemplified in the rapid diffusion of technological innovations that have transformed human culture.

CONCLUSION

Comparison of nonlinear systems theory, post-processual archaeology, and feminist theory has revealed a number of synergies and areas of potential synthesis among these paradigms. A number of nonlinear patterns and processes have been shown to be relevant archaeologically, either directly or indirectly as

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analogs for archaeological processes. Further, it has been argued that many processes previously identified in archaeology are nonlinear processes. It has been briefly argued that culture meets the criteria of a nonlinear system, including the potential for chaos.

If culture and cultural processes are nonlinear, then archaeological theory and method needs to be expanded with nonlinear systems theory and methods in order to be able to analyze nonlinear processes. Comparison of nonlinear systems theory, feminist theory, and post-processual archaeology has shown major areas of congruence and synergy that suggest areas of potential synthesis among these theories. Differences among these theories have led to suggestions for potential expansions of these paradigms.

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