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Toward a Chaotic World View

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Abstract

The field of psychology has been largely governed by classical world views and root metaphors. The present work suggests that, similar to the physical sciences, a view of human actions as chaotic may be appropriate and even advantageous. Chaotic systems can be characterized by their obeying of rules, nonlinear interactions, and sensitivity to initial conditions. These qualities can apply to social systems as well and examples are given. Using a chaotic world view, new tools and methods can applied to existing and future research. Citations from the literature show how chaos and fractals are being applied in various aspects of psychology.

Toward a Chaotic World View

"When anyone has a problem before him and is at a loss how to handle it, he looks about in his available experience for some analogy that might suggest a solution." (Pepper, 1967, p. 3) The world view and root metaphors that a practitioner holds will greatly impact how he views the psychology of human development (Super & Harkness, 2003). Pepper (1942) identified four world views, each with a corresponding root metaphor: formism, mechanism, contextualism, and organicism. The world view of formism is that the world can be categorized and classified; its root metaphor is similarity or type. The mechanistic view holds that everything operates in a cause-and-effect fashion, like a machine. Implicit in this view is regularity: the causes operate on effects resulting in smooth, regular movements. In a contextualist world view, the context surrounding an event is all important and the meaning of an event is relative to that context. With organicism, the world is seen as a coherent whole. An individual is an element in a system and conflict resolution leads to increasing the harmony of the system.

The present work suggests a alternative world view, one based on the dynamical system concept of chaos. This view encompasses some of the aspects of Pepper's four world views and may present some advantages for the investigation of psychology.

Chaos

As used in mathematics and the physical sciences, "chaos" is a property of a dynamical system. Chaos has been discussed widely in the past twenty years, both in the academic literature and popular press. See, for example, Gleick (1987) for a discussion accessible to the layperson or Mandelbrot, Evertsz, Jones, & Gutzwiller (2004); Peitgen, Jürgens, & Saupe (2004); or Weisstein (n. d.) for more technical treatments. A chaotic system has dynamics that are not periodic and not easily predicted, but also not formless or stochastic. In particular, chaotic systems are deterministic systems of interacting elements. The rules governing the interactions are nonlinear and this gives the system sensitivity to initial conditions. That is, two (or more) trajectories that begin very close to one another will quickly diverge. However, chaotic trajectories are generally bounded and well characterized in the aggregate. As an example, consider the weather—the temperature six weeks from today can't be predicted exactly, but it can be placed within a limited range with great confidence. Chaos also occurs in systems as varied as financial markets (Mandelbrot & Hudson, 2004) to brain waves (Basar, 1990).

An illustration is shown in Figure 1 (by the author). Here, the paths in space of five points in a chaotic flowfield (such as smoke particles) are plotted; each path in a different color. At the far left of the image, all five traces are together, indicating that the points begin at very similar locations. However, as the particles move generally to the right, their paths become less correlated, until at the far right of the image, they bear scant resemblance to each other.

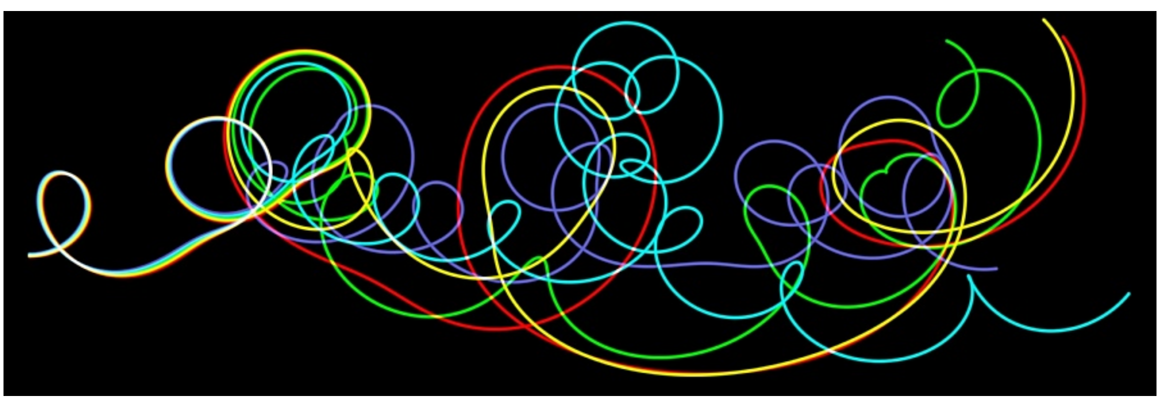

Figure 1. Illustration of five paths in a chaotic system.

While not as quantitative as physical systems, human systems can be considered from a chaotic framework. Biologically, humans are chemical and electrical systems, subject to the laws of physics. Alternatively, if one subscribes to a mechanistic world view, then he or she already believes that people obey certain rules (albeit, not necessarily physical in nature). Also, people are not linear in any manner, from sensory responses to stimuli (e.g., Stevens' (1957) power law), to Ebbinghaus' classic forgetting curve, to reactions to traumatic events. Interactions between people (or even between various aspects of the same person) can provide the feedback needed for chaos.

In their “mini mind map” word exercise, Buzan & Buzan (1996) demonstrate human chaos (although the exercise is actually about brainstorming). In a group, everyone is given a base word, such as “happiness.” Each person then quickly writes down the first 10 words that they associate with the base word, without discussing their words with anyone else. The authors relate that, invariably, there will be little correlation between the words chosen and very few, if any, words common to more than a few people. In terms of chaos, each list of words can be considered a dynamical “path.” The rules of the activity are the same for everyone, but everyone comes to it with their own store of word associations, which serve as internal nonlinear interactions. Thus, each path is different and one cannot be predicted by looking at another.

Anecdotally, we know that the slightest difference in context or nuanced conversation can lead to dramatically different outcomes. Consequently, great differences may be seen in people who began life similarly (e.g., twins or schoolmates). Or, people who go through similar experiences may be affected by it in profoundly different ways. However, for all our differences, people do indeed share some psychological characteristics and can be described well in the aggregate. Thus, the tools and concepts of chaos may indeed be an appropriate framework from which to study psychology.

A Chaotic World View

A chaotic world view would see people as elements in a chaotic system (the world) or would envision most any social system as chaotic. Like Peppers world views, this would be more of a philosophical framework than a theory and would not immediately lead to testable hypotheses. Due to the tenets of chaos, this view would be more consistent with some established theories and less so with others.

An individual's chaotic behaviors are, by definition, not predictable in the long term. Accordingly, any theory that advocates a firm timetable of developmental stages would not fit well with this paradigm. Notable examples include theories of Freud, Piaget, and Erikson (as discussed in Miller, 2002). Also, early work in cognitive information processing tended to present a static model of a developmentally mature learner (Nakagawa, 2008) and would not adequately reflect the dynamics of a chaotic system.

Conversely, any theory that emphasizes dynamics and the importance of the individual and of interaction should mesh well with a chaotic world view. In particular, Bronfenbrenner (1995), in discussing his process-person-context-time model, states two propositions underlying his bioecological paradigm. In part, the first reads, "... human development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate environment." (p. 620) Proposition 2 says,

> The form, power, content, and direction of the proximal processes effecting development vary systematically as a joint function of the biopsychological characteristics of the developing person; of the environment, both immediate and more remote, in which the processes are taking place; and the nature of the developmental outcomes under consideration. (p. 621)

These propositions can be taken to show that the developing individual interacts strongly with his or her environment and that these interactions affect development which, in turn, affects the environment, affecting future development, and so on.

Bandura’s (1977) social cognitive theory might also fit well within a chaotic world view. According to Bandura, people learn through observations of others, whom the learner has judged to be competent, powerful, and relevant to the learner’s need to learn. Also, the learner must be motivated by some internal goal or drive. Quite naturally, one learner’s goals may differ from another’s, even in the same physical situation. Different learners will also observe different models differently and may choose different aspects of the modeled behavior from which to learn. As a result, the process of observational learning may vary widely from one learner to the next, even in a tightly controlled environment such as a classroom, leading to widely diverse outcomes.

Cognitive information processing (CIP) uses the model of the mind as a digital computer. As Driscoll (2005) discusses, CIP deals extensively with the physical nature of the brain, memory, and the senses, areas which are rife with nonlinear relationships. For example, in the Gestalt principles of organization (p. 84), the principle of closure is essentially a binary property: a set of discrete elements either closes for an individual or it doesn’t. Or, the position effect in working memory (the last items in a list are remembered best, then first items, then those in the middle), illustrated by the serial position curve (p. 88). If the fundamental physical elements of cognition operate nonlinearly, it may be expected that this is manifested ultimately in behavior and in development.

“Classical” CIP treats the mind as a computer; van Gelder (1998) argues that this is an evolution of Thomas Hobbes’ notions of calculations representing the internal workings of the mind. As a richer alternative, van Gelder hypothesizes that the mind (indeed, all cognitive agents) is really a dynamical system. If that view is accepted, then chaos can occur in the mind by itself, instead of the mind “merely” being an element in a larger chaotic system.

Possible Future Directions

Kuhn (1962) states that the paradigm under which a scientist works will affect that which he or she sees. Moving from an established paradigm to a new one allows the scientist to quite literally see things that couldn't be seen before. Embracing a chaotic world view might allow social scientists to make greater use of the tools and techniques of mathematicians and physical scientists, which might lead to at least a different view of things, if not entirely new views. Heiby (1995a, p. 5) echoes this view: "We propose that the conceptualization and assessment of unstable behavioral disorders can be strengthened by incorporating elements of chaos theory and nonlinear dynamical modeling."

One such view is that of fractal geometry. Fractals are shapes that visually represent chaos; see the above-mentioned references on chaos for more information on fractals. Fractals are characterized by their roughness, as opposed to the smoothness of classical shapes, such as circles. In Figure 2 (by the author), a circle is magnified. It, like any smooth shape, eventually becomes indistinguishable from a line, under magnification. This is related to the use of such shapes in portraying classical dynamics, often motivated by linear systems. In contrast, a fractal (such as the Mandelbrot set, shown in Figure 3) never becomes smooth under magnification, but reveals more detail. This is related to the roughness often seen in graphs of chaotic systems.

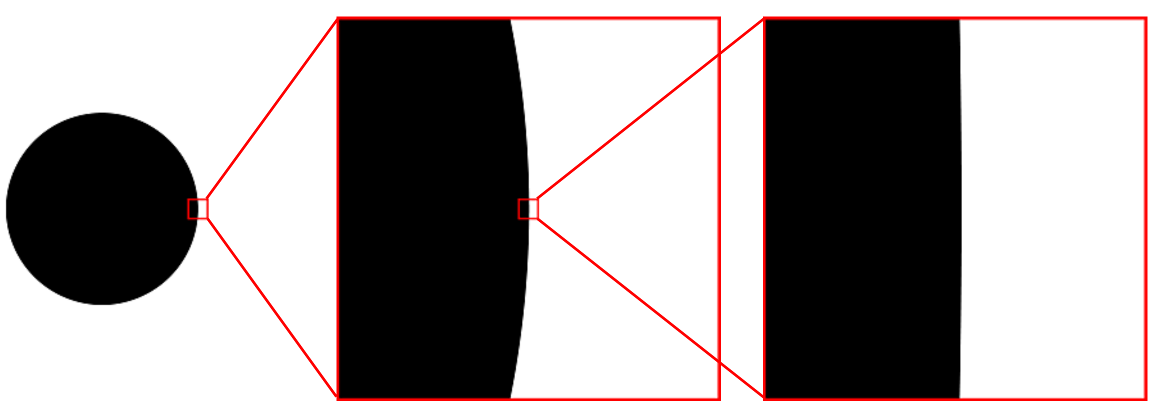

Figure 2. Magnification of the edge of a circle, showing its smoothness.

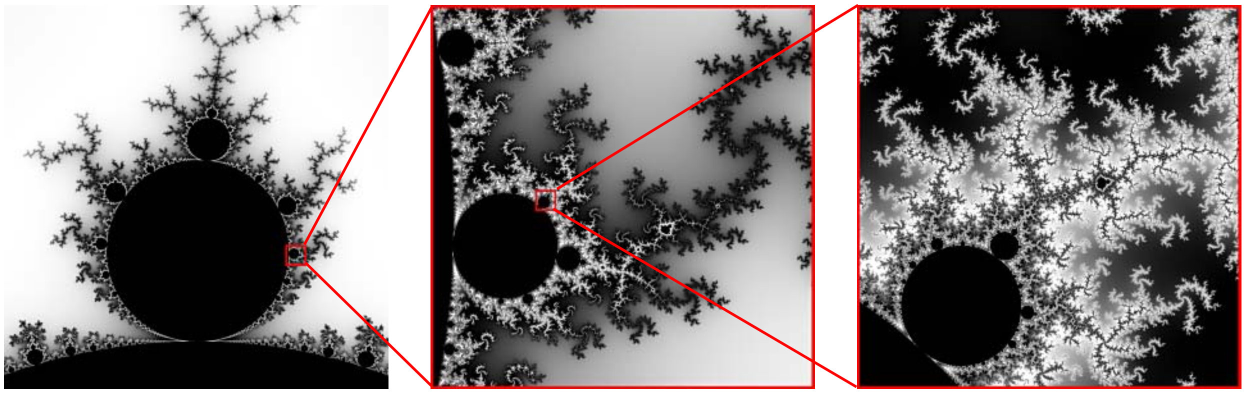

Figure 3. Magnification of the edge of the Mandelbrot set fractal, showing its roughness.

Fractals are beginning to be used in Psychology. They have been found in the analysis of mood data for a patient with episodic depression (Heiby, Pagano, Blaine, & Heath, 2003); a fractal graph of self-reported mood data suggests a chaotic component to depression. Butz (1992) used a fractal to express his model of development, an extension of the notions of Freud, Jung, and Erikson. In Butz's model, development is marked by windows of chaos interspersed in relatively calm periods of bifurcated growth. Hood (2006) envisions a fractal model of development in which the different time scales of life (e.g., clock time, cultural time, developmental phases) overlap and intertwine. She also discusses a schematic trajectory through a fractal psychological space of multiple domains. Interactions between the domains might be considered as, "...state-dependent and novelty-generating regions, and fractal boundaries as locations of behavioral oscillations" (p. 237). A model of such interactions is shown in Figure 4. The various domains are coded by color. The boundary between any two domains is a fractal, composed of infinite small regions of the other domains. In this model, a path from one domain (blue) to another (magenta) involves passage through the other two (green and yellow) multiple times. This might appear as a chaotic voyage, if not pathological.

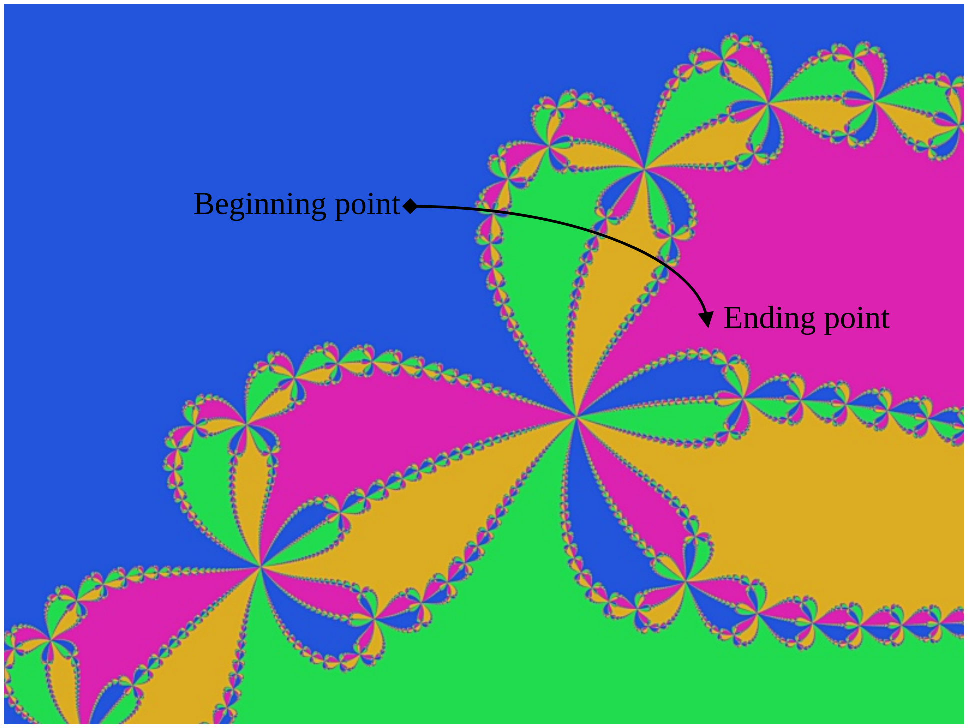

Figure 4. Model of a path through a fractal psychological space, after Hood (2006).

Conclusions

The field of psychology has been largely governed by one of, or a combination of, the four world views brought forth by Pepper (1942). The current work suggests that, similar to the physical sciences, a view of human actions as chaotic may be appropriate and even advantageous. Chaotic systems can be characterized by their obeying of rules, nonlinear interactions, and sensitivity to initial conditions. These qualities can apply to social systems as well. Given a chaotic world view, new tools and techniques can be applied and old questions looked at in new ways. Some of this work has begun, with novel approaches in the analysis of data and modeling of development.

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