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Fractals as Transpersonal Metaphor

Commentary on Marks-Tarlow's "A Fractal Epistemology for Transpersonal Psychology")

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George Carlin noted that we say there was "hail the size of golf-balls" or "hail the size of baseballs, but why, he complained, isn't hail ever the size of hail?" We face a similar problem in describing living things and especially their cognitive functions. We do not really understand the brain or how it works, and so we don't know *how* to describe it. Instead we use metaphors to describe it. What is really odd is that the only metaphors that we can think to apply to biology and cognitive function are based on the machines that we build. Is that because those machines are really the only things we understand because we built them ourselves?

The ancient Greeks, experienced in building machines with pipes and fluids and steam thought of the brain as a set of interconnected and functioning pipes. Later we thought of the brain as a telephone switching network. Then the brain was a computer. Now it is a neural network. Guess what, the brain is not pipes, or a telephone network, or a computer, or a neural network. It is a brain. It functions like a brain, not like pipes, or a telephone network, or a computer, or a neural network.

This struggle to find the right metaphor to capture transpersonal psychology is the subject of Terry Marks-Tarlow (2020, this issue; subsequent references to her refer to this) article. Her novel proposal is that a useful metaphor for transpersonal psychology, is not a machine at all, but an area in mathematics called fractal mathematics. Fractals have some very interesting properties (Mandelbrot, 1983; Barnsley, 1998; Liebovitch, 1998; Liebovitch, and Scheurle, 2000; Brown and Liebovitch, 2010). A fractal has an ever larger number of ever smaller pieces that resemble the whole object, like the ever smaller branches of a tree. This property is called *self-similarity*. The tree has only a few large branches, but more medium sized branches, and a very larger number of small branches. There is no such thing as the "average" size of a branch. The closer you look, the finer the size of the branches you see. There is a relationship between the number of branches of different sizes. This property is called a *scaling relationship*. Because there is no average size of a branch, the statistics of fractals is very different than those bell curves that they taught you in school. A *fractal distribution* of measurements has a much higher probability of a value that is very far from the average than that bell curve. Those values are not "outliers," as they are an essential part of the fractal distribution of values.

Fractal mathematics has been used to provide a more realistic description of the shapes of things in the natural world, such as rivers and mountains and clouds. It has proved useful in providing a detailed mathematical analysis and an understanding of the properties of physical, biological, and social systems. These include such things as the fluctuating light intensity from very powerful, very distant astronomical objects call quasars (Press, 1978), extraneous voltage noise generated by electronic chips (Milotti, 2002), the random walk of molecules moving through a material (Ben-Avraham Havlin, 2000), the patterns formed by injecting a light fluid (such as water) into a heavy fluid (such as thick oil) (Maloy, Feder, & Jossang, 1985), and the statistical distributions of the populations of cities, number of casualties in wars, frequency of earthquakes, and your delay times in replying to emails (Richardson, 1960; Mandelbrot, 1983; Bak, 1996; Barabasi, 2005).

In my own research, understanding and appreciating these properties of fractals has helped us to better analyze and understand phenomena in different systems. Ion channels are proteins in the membranes of all cells that let ions like sodium, potassium, and chloride into and out of cells. These proteins act like tiny switches, ever changing between shapes that are either open or closed to flow of those

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ions. Using the technique called patch clamp, we could measure the tiny electrical currents though an individual ion channel. When we measured the current at ever shorter time resolutions, we found ever shorter open-time durations. We could use the scaling relationship between those short and long durations to provide information on the dynamics of how the protein wobbles and twists itself between its conformation shapes that are open or closed to the flow of ions (Liebovitch, Fischbarg, & Koniarek, 1987; Liebovitch & Sullivan, 1987; Liebovitch, 1989; Liebovitch et al., 2001; Liebovitch & Krekora, 2002).

In another project, we studied the fluctuation of commodity prices in ancient Babylon recorded in cuneiform on clay tablets. We found that there are fractal fluctuations in those prices at many different time scales, just as there are many different spatial scales in the sizes of the branches of a tree. As similar fractal fluctuations are present in modern financial data, we could confirm the market nature of this economy over 2,000 years ago (Romero et al., 2010).

We also found that fractal statistics were helpful in analyzing patterns of human behavior. In a social psychology experiment, two people with different opinions on an emotionally charged topic, such as abortion, affirmative action, death penalty, or euthanasia, were asked to talk for 20 minutes and see if they could prepare a joint statement. During these difficult conversations each person spent time trying to understand the other's position, which is called prosocial behavior, or time pushing their own views, which is called proself behavior. Typically, they spent some time in one of these behavioral states and then switched to the other, and then back again. In a way, this is analogous to the ion channel proteins being either open or closed to the flow of ions and switching between those two states. Analyzing the audio recordings of these conversations, we determined the fractal scaling relationship between the times spent in the prosocial and proself states. That scaling relationship revealed that their previous behavioral states influenced the duration of their subsequent behavioral states. The probability to switch out of each behavioral state decreased with the time already spent in that behavioral state (Kurt et al., 2014).

Appreciating the properties of fractal statistics also helped us in our studies of the timing of heart attacks, called atrial tachyarrhythmias, where the smaller chambers of the heart beat too fast instead of more slowly and smoothly contracting to pump blood out of the heart. In those patients, a small implanted electrical device, called an implantable cardioverter defibrillator (ICD), senses the problem and sends a strong electrical signal throughout the heart to restore its normal function. That ICD is also a small computer and has a radio transmitter which can play back information to us about the times when it was triggered to restore normal heart function. Fractal statistics, not a bell curve, was a much better fit to the data of the times between the events when the device triggered. The fractal approach provided us a better quantitative measure of how the number of short times between events compared to the number of long times between events (Liebovitch et al., 1999, Shehadeh, Liebovitch, & Wood, 2002).

Marks-Tarlow shows how many of those fractal mathematical properties are also present in the fascinating dance of the intrapersonal and interpersonal worlds. Therefore, fractal mathematics can also provide an appropriate epistemology for transpersonal psychology to describe the "*structure* of subjective experience." She notes that the shadows the fire casts on the cave wall from these transpersonal phenomena (this is not an original metaphor due to me) have some of these properties in common with fractal mathematics:

- Fractals are objects with an infinite repetition of smaller pieces that reflect the whole*, like the interconnections between different levels of experience*.
- There is no single value for the measurement in a fractal, the values measured depend on the scale of the measurement, *like the relativity of subject experiences*.
- Fractal boundaries between different mathematical solutions of a nonlinear mathematical problem have interpenetrating boundaries, *like the connections between intrapersonal and interpersonal experiences*.
- Fractal patterns can be generated by complex feedback loops, *like the "complex feedback*

loops between inner and outer processes, such as self and other".

- Fractal patterns are represented by statistical distributions that have a much higher likelihood of unanticipated "black swan" events than bell curves, *like the frequency and power of peak experiences.*

These and many other examples that she presents make a novel and strong case for a fractal metaphor. Is this the best metaphor for transpersonal psychology? Certainly it is a much more appropriate metaphor, a much closer fit to observed human experience, than simple Euclidean forms, Newtonian one simple cause to one simple effect, and the statistics of the bell curve tightly wound around a single population mean. In its resonance with human experience, this fractal epistemology has much to contribute to our understanding and how we conceptualize and reason about human experience. Is it the only metaphor for transpersonal psychology? As the psychologist Abraham Maslow (1966, p. 15) noted, «I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail." We need as many different tools as possible, and in that toolbox, Terry Marks-Tarlow has given us another fine and useful tool.

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Larry S. Liebovitch, PhD, is Professor of Physics and Psychology at Queens College of the City University of New York and serves as Adjunct Senior Research Scientist for AC4 at Columbia University. At Florida Atlantic University he served as the interim director of the Center for Complex Systems and Brain Sciences and has used nonlinear methods to analyze and understand molecular, cellular, psychological, and social systems, including as of Fractals and Chaos: Simplified for the Life Sciences (Oxford University Press, 1998) and coauthor of Fractal Analysis in the Social Sciences, Quantitative Applications in the Social Sciences, Volume 165 (SAGE Publications, 2010). Liebovitch's commentary emphasizes the organic quality of the fractal metaphor versus the mechanical metaphor more traditionally used to describe biological and cognitive functions, based on human-made machines and dating back as far as ancient Greece.

About the Journal

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