Loma Linda University

TheScholarsRepository@LLU: Digital Archive of Research, Scholarship & Creative Works

Loma Linda University Electronic Theses, Dissertations & Projects

12-2008

Nonlinearity and Gestalt Therapy : Back to the Beginning

Darryl G. Kim

Follow this and additional works at: https://scholarsrepository.llu.edu/etd

Part of the Psychiatry and Psychology Commons

Recommended Citation

Kim, Darryl G., "Nonlinearity and Gestalt Therapy : Back to the Beginning" (2008). *Loma Linda University Electronic Theses, Dissertations & Projects*. 629.
https://scholarsrepository.llu.edu/etd/629

This Doctoral Project is brought to you for free and open access by TheScholarsRepository@LLU: Digital Archive of Research, Scholarship & Creative Works. It has been accepted for inclusion in Loma Linda University Electronic Theses, Dissertations & Projects by an authorized administrator of TheScholarsRepository@LLU: Digital Archive of Research, Scholarship & Creative Works. For more information, please contact scholarsrepository@llu.edu.

LOMA LINDA UNIVERSITY
School of Science and Technology
In conjunction with the
Faculty of the Department of Psychology

Nonlinearity and gestalt therapy: Back to the beginning

By

Darryl G Kim

A Doctoral Project submitted in partial satisfaction of
The requirements for the degree of
Doctor of Psychology

December 2008

©2008

Darryl G Kim
All Rights Reserved

Each person whose signature appears below certifies that this doctoral project in his/her opinion is adequate, in scope and quality, as a doctoral project for the degree of Doctor of Psychology.

_______________________________, Chairman
Todd Burley, Professor of Psychology

____
Mary-Catherin (Kiti) Freier-Randall, Professor of Psychology

____
Robert Resnick, Clinical Psychologist

ACKNOWLEDGEMENT

I would like to express my appreciation to the individuals helped me complete this work. I am grateful to Loma Linda University Department of Psychology for providing the facilities and environment. I wish to thank the members of my guidance committee, Todd Burley, Kiti Freier-Randall, and Robert Resnick. I am also very grateful to Shari Lane for her constant assistance.

TABLE OF CONTENTS

Approval Page iii

Acknowledgements .iv

List of Illustrations vii

Abstract. x

Chapter

1. Introduction .1

2. Gestalt History Revisited. 3

3. Basic Features of Gestalt Therapy. 7

4. Lewin's Work 12
   Original Equations 14
   Psychological Significance of the Equations. . 11
   Restatement for Nonlinear Dynamics 17

5. What is Nonlinear Dynamics: A Primer on ODC and Nonlinearity 18
   One-dimensional Linear and Nonlinear Dynamics. 25
   Bifurcations 29
   Saddle Point Bifurcations 29
   Transcritical Bifurcations. 31
   Pitchfork Bifurcations. 32
   Imperfect Bifurcations(Catastrophe) 35
   Two-dimensional linear systems 38
   Chaos and What's not covered 38

6. Human Interaction Equations. 40

7. Nonlinearity and Gestalt Therapy 42
   Field Theory Revisited 53
   Phenomenology. 61
   Figure/Ground. 62
   Contact. 63
   Resistances (Bounding Anomalies) 65

8. Value of Nonlinear Equations 68

References 74

LIST OF ILLUSTRATIONS

Figure 1. Figure-Ground 8

Figure 2. Contact 9

Figure 3. Attractors and Bifurcations 22

Figure 4. Nonlinear Sinusoidal Plot 27

Figure 5. Saddle Point Functions. 30

Figure 6. Saddle Point Logistic Diagram 31

Figure 7. Transcritical Bifurcations. 32

Figure 8. Transcritical Logistic Diagram. 32

Figure 9. Pitchfork Bifurcation 33

Figure 10. Pitchfork Logistic Diagram 34

Figure 11. Unstable Pitchfork Logistic Diagram. 35

Figure 12. Pitchfork Stable and Unstable States 35

Figure 13. Catastrophe Bifurcation. 36

Figure 14. Catastrophe Phase Diagram. 36

Figure 15. Catastrophe Logistic Diagram 37

Figure 16. 3D View. 37

Figure 17. HKB model of coordination expressed as a vector field (Kelso, 1995) 48

Figure 18. Types of basins of attraction (Barton, 1994) 51

Figure 19. Individual field at time T=0 55

Figure 20. Overlapping fields of two individuals, one who is not aware of the other at T=1 . . 56

Figure 21. Overlapping fields of two individuals as both become aware of each other at T=2 . 58

Figure 22. Overlapping fields to two individuals who become engaged in conversation at T=3. . 59

ABSTRACT OF THE PROJECT

Nonlinearity and gestalt therapy: Back to the beginning

By

Darryl G Kim

Doctor of Psychology, Graduate Program in Psychology
Loma Linda University, December 2008
Dr. Todd Burley, Chairperson

Gestalt methods are explored in the context of the nonlinear view. The original Lewinian equations are updated to the current notions of nonlinear dynamics and current Gestalt Therapy theory. Ordinary differential equations and nonlinear processes are applied some of the key features of Gestalt Theory. Theoretical positions are explored and therapeutic impact considered.

CHAPTER 1

INTRODUCTION

A number of researchers within the Psychological community have suggested the possible connection between nonlinear dynamics and gestalt theory. Nonlinear dynamics is also known as chaos theory, nonlinear dynamics systems theory, and self organization. Among the researchers that have suggested the relationship between psychology and nonlinearity, Kelso (1995) posited that "Perceptual organization is not a new idea, of course, although perceptual self organization and dynamics might be. Perceptual organization lies at the heart of Gestalt psychology." While Kelso's application of nonlinearity is only to the Gestalt psychology and not to Gestalt therapy, others such as Gottman, Murray, Swanson, Tyson, & Swanson, (2002) have applied nonlinearity to therapeutic family therapy using a chaos model. This paper is about the connection between nonlinearity and gestalt therapy. The purpose of this thesis is to describe Gestalt therapy and nonlinear dynamics and how they are related. The intent is to also describe possible nonlinear equations that may provide more information about human interactions. Finally, the purpose of this paper is to describe possible problems with these ideas.

It appears that the very beginnings of Gestalt psychology and thus, Gestalt therapy may have some of the mathematical underpinnings of nonlinearity. This is explored in the light of new understandings of the mathematics of nonlinearity. Many of the principles of nonlinearity appear especially applicable to Gestalt therapy principles. These are explored in depth. Also discussed are possible human dynamics equations and the problem concerns with nonlinearity and gestalt therapy.

CHAPTER 2

GESTALT HISTORY REVISITED

In 1910, a confluence of events brought together at the University of Vienna those who would be the founders of the Gestalt movement, Max Wertheimer, Kurt Koffka, and Wolfgang Kohler. Wertheimer had received his doctorate from University of Würzburg in 1904, while Koffka and Kohler had matriculated at the University of Berlin in 1908 and 1909, respectively. In 1910 they began 3-year collaboration in studies in "Gestalt Psychology." Along with Kurt Lewin who also graduated from the University of Berlin in 1916, these men were the main contributors to Gestalt Theory. Their work forms the basis for the general Gestalt therapy - field theory, phenomenology, figure/ground, dialogue, resistances, and the gestalt experiment. (Ash, 1995)

The Zeitgeist of the times was one of change. It was the turn of the century. James Clerk Maxwell in 1873 published his work on Gaussian fields and Hendrick Lorentz in 1904 completed the mathematics to describe the field behavior. Old Newtonian physics was increasingly under pressure to explain new phenomena and was failing to account for the discrepancies. In 1901 Max Plank discovers Plank's Law and in 1905, Albert Einstein publishes his treatise On the Electrodynamics of Moving Bodies for which Nobel prizes are awarded to Plank in 1918 and Einstein in 1921, establishing Quantum Theory and making Newtonian physics as a subset of Quantum Physics. In 1926, Erwin Schrodinger develops the mathematics to evaluate the Quantum Theory and is awarded the Nobel Prize in Physics in 1933. Werner Heisenberg discovers the Heisenberg Uncertainty Principle in 1927.

Meanwhile in the fledgling science of psychology, the work of Gustav Fechner still held sway in theoretical models. It was not until the 1870's did its influence begins to wane. Charles Darwin in 1871 published his Descent of Man, and Wilhlem Wundt publishes Principles of Physiological Psychology, Franz Bretano publishes Psychology from an Empirical Standpoint (an important influence on the evolution of Gestalt therapy), and in 1879 Wundt establishes the first Psychology Lab at the University of Leipzig. By the 1890's psychology had moved overseas to America with the publication of The Time taken up by Cerebral Operations by James McKeen Cattell in 1886, Principles of Psychology by William James in 1890, the founding of the American Psychological Association in 1892, and Animal Intelligence by Edward Thorndike in 1898.

However, the beginning of the next century was to be dominated by the Europeans with the publication of the Interpretation of Dreams by Sigmund Freud (1900), Charles Spearman's work on general intelligence (1904), Ivan Pavlov publication of Classical Conditioning (1906), Alfred Binet's work testing of child intelligence (1908), and Freud's publication of The Origin and Development of Psychoanalysis (1910).

The founders of Gestalt psychology were influenced by the events of the times. Their education in German universities was classical. That is, they would have been exposed to the literature and science of the day, including the latest in physics. Their published work indicates this. Wertheimer published Gestalt theory in 1924 where he suggests that gestalt theory is as rigorous as a mathematical formula. Kurt Koffka published Principles of Gestalt Psychology in 1935, which begins, with comparison of Gaussian fields and perceptual fields (pg. 42-43). Lewin published On the Structure of the Mind in 1922. He begins the treatise with an analogy of energy as a metaphor for developing psychological structures of the mind like developing energy balance equations (pg. 46).

Fritz Perls in Ego, Hunger and Aggression (1947) established the basic view and principles of the Gestalt process. The development of Gestalt therapy and practice continued to develop with ideas from Fritz Perls, Laura Perls, Paul Goodman, and Isadore Fromm. These thinkers brought to the development of Gestalt an unusual mix of intellect from philosophy, literature, psychology, and psychiatry with an eclectic set of interests that encompassed the arts, gender, politics, and eastern religions. The founders' own educational backgrounds added influences from existentialism, sociology, social and the psychology of perception. In the case of Fritz Perls, he worked under the neurologist Kurt Goldstein and was influenced by Goldstein's idea that orgamic self regulation could only take place as part of self transcendence, that is viewing self as part of a whole. The phenomenological and ideological roots were based on the works of Edmund Husserl (1931), Otto Rank (1958), and Martin Buber (1958)

CHAPTER 3

BASIC FEATURES OF GESTALT THERAPY

As previously mentioned, the main features of Gestalt theory are field theory, phenomenology, figure/ground, dialogue, resistances, and the gestalt experiment. The resultant was an emphasis on awareness (sensation, perception, and pattern recognition), a central focus on the here and now, and the notion that therapist and patient together collaborate to make sense out of random experience (Hall and Lindzey, 1970).

Think of gestalt therapy as a series of interconnected processes. In reality during the therapeutic process the overlap and changes dynamically based on the phenomenology of the patient and the therapist in the moment.

The place to begin is the field because the field is always present and because the field can viewed as many component fields which can be studied such as a phenomenological field and a separate perceptual field.

Briefly, the phenomenological field is the sum total of all the person's experiences, thoughts, and feelings guided by attentional processes. The field includes the past, unfinished business and present. Against the background of the field are figures formed, and hopefully ultimately resolved. The field is the context.

The phenomenological field is polarized between figure and ground. The figure is that aspect of experience which is biologically based and the focus of attentional processes and drive behavior. The figure is also the general comparison between the person and phenomenology of the person. The ground is a source within the person's phenomenological field (Figure 1).

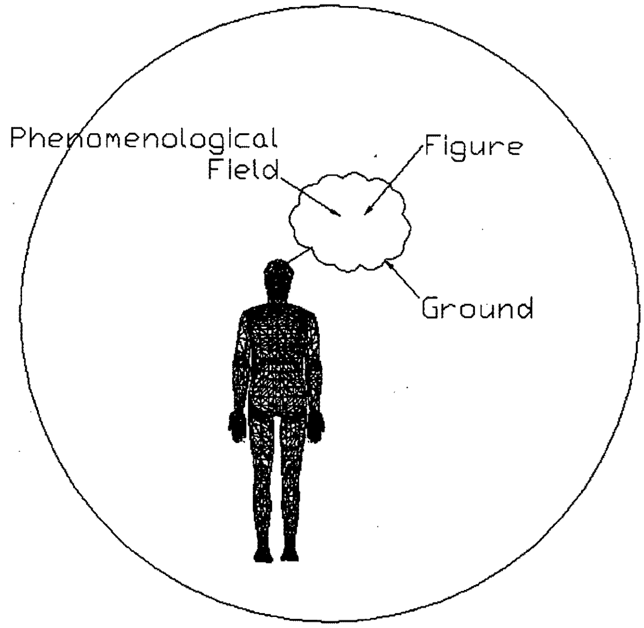

Figure 1. Figure-Ground

Next is Contact. Contact is the boundary between I-ness and other-ness. Perls et al (1951) describe contact as "…fundamentally, an organism lives in its environment by maintaining it differences and more importantly by assimilating the environment to its differences; and it is a boundary that dangers are rejected, obstacles are overcome, and that is assimilable is selected and appropriated. " Actually, the contact boundary itself is the boundary formed by the phenomenology of one person (I-ness), a minimal space, and the boundary formed by the phenomenology of another person (other-ness); sort of two bubbles next to each other where exchange is possible and presentable (Figure 2).

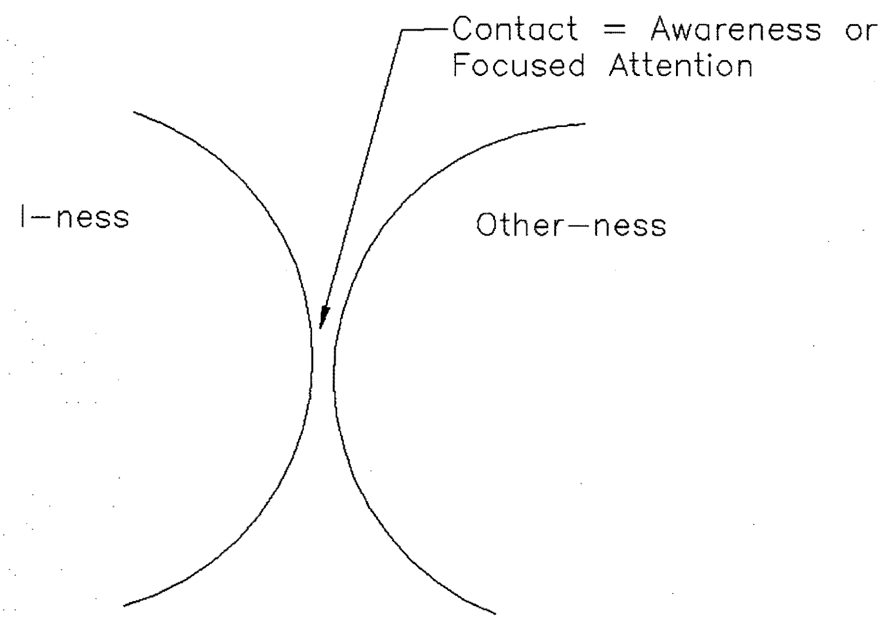

Figure 2. Contact

Further, within the organism there exists a contact boundary within. Since the contact boundary moves with the "I" which focuses the "other", it is free to move within the person as well to the larger field outside of the person.

The product of contact is awareness. Awareness focuses attention. Dialogue is the subset of contact. Dialogue is a specialized form of contact.

Dialogue is the medium of primary contact is explored. The therapist is mindful of his or her own presence, and creates a respectful and safe emotional space for the client to enter and become present as well. Therapists are committed to dialogic process where the therapist presents as a whole and authentic person instead of assuming a role, false self, or persona and where the therapist trusts in the process and does not attempt to save himself.

The goal of the phenomenological method is awareness. When employing the phenomenological method, the therapist works to reduce the effects of bias through repeated observations and inquiry.

Resistances represent past attempts by the patient to cope with existing situations based upon past successes. Resistances are contextual. Resistances may be ingrained in the personality of the patient and must be worked to minimize their effect on patient behavior.

Often the resistance is very strong. The Gestalt therapist can here, employ the Gestalt experiment. In gestalt therapy this is an attempt to bring about awareness and action on the part of the patient. The patient is encouraged to deal with his demons and play out his feelings and actions within the safety of the therapeutic relationship.

CHAPTER 4

LEWIN'S WORK

Of interest are the efforts of Gestalt theorists to use mathematical expressions of psychological theory. As previously mentioned Wertheimer, Koffka, and Lewin used a physics analogy and mathematical treatise to demonstrate their ideas. Of the three, Lewin's was the most advanced given the mathematics of the time.

Lewin begins his work A Dynamic Theory of Personality (1935) with a series of propositions that are not unlike what present day physicist would use to construct a "thought" experiment. Then he proceeds to make a bridge from physical science by suggesting the relationship between physics and psychology is more in principle than in exact procedure (pg. 46). He argued the field should be considered in terms of perception or phenomenologically. Of course, this represents the limits of Lewin's mathematical knowledge. Non-linear dynamics is a product of the space program and weather forecasting, a 1980' development.

Lewin's departure from more rigorous treatments is partially driven by the lack of mathematical technology. He did not have the computing power and the mathematical understanding of nonlinear dynamics that are available today. Kelso (1998) suggested that the effort to maintain a mechanistic connection to the physics of the time may have been misguided. While this ultimately led to the development of a field theory that was psychologically oriented, a mathematical model of field theory may have been obscured. Kelso suggests nonlinear dynamic parallel processing may yield a more pragmatic understanding about dynamical processes.

Dynamics were always an expressed part of the original gestalt theory. Kohler (1947) argues that human existence has, as one of its characteristic properties a dynamic factor (pg. 63). Kohler (1935) indicated dynamics was a useful property of the field (pg. 46). One of the arguments made by Perls (1951) was that the straight line processes suggested by psychoanalytic writers were not like the actual processes that were experienced during therapy. Perls postulated that the notion that behavior was not determined by the parts, but by the whole and that the study of Gestalt would reveal the nature of the wholes (pg. 27). The modern nonlinear dynamics provides a more robust model of field theory especially as it considers the value of understanding the whole.

Original Equations

The Lewin explanation of field using a physics analogy is typical for the times. It begins with the notion of a mathematical descriptor of the field at a given moment (Lewin, 1943).

$$dx/dt = F(S^t) \quad (1)$$

This is the expression for change at time t for field (F) for situation (S). This is written in the standard form denoting the instantaneous change moment to moment. In it, the equation is a statement of the dynamics of change taking place in the field of a person.

Lewin writes that the field of moment does not depend on past or future situations. He further extends the physics equation to an equation for behavior.

$$b^t = F(S^t) \quad (2)$$

His main argument for this extension is b^t is the equivalent of dx/dt in psychology. It is an attempt to use the linear logic of physics of the time to explain behavioral phenomena.

Psychological Significance of the Equations

Lewin then proceeded to begin a process of allowing of a relation between a change and a past situation, limiting this to a "closed system" where the conditions between a change and a past situation are known. Later Lewin argues, "the psychological past and the psychological future are simultaneous parts of the psychological field existing at time *t*. The time perspective is continually changing. According to field theory, any type of behavior depends upon the total field, including the time perspective at that time, but not, in addition, upon any past or future field and its time perspective." (pg 54)The field is the present, past, and future at the moment. The field changes in the next moment (Lewin, 1951). This concept is clearly recognizable in Perl's later writings.

From a nonlinear view, each macro process has an underlying equation that is not only deterministic, that is, all the inputs or variables are known, but also predictable in the sense that outcomes can be calculated.

From a therapy perspective, Lewin's assertion implies that what a therapist is observing changes constantly. In the process of observing the client, the therapist cannot help notice certain themes that continue to emerge and strengthen against a background of other information and situations.

The nonlinear equation also provides a fertile ground for the concept of contact. The very process of talking with a client is an exchange. Thus some sort of contact will be made in that talking process. Therefore the patient's phenomenological field is perturbed and the equation altered.

Finally, the equation indirectly suggests a here and now approach. Note again that dx/dt or b^t is the instantaneous change or the change moment to moment. This dynamic change is in the here and now and is expressed as:

$$dx/dt = F(S^t) + F^1(S^{t-1}) + F^2(S^{t+1}) \qquad (3)$$

Where the moment to moment change is equal the instantaneous field plus the moment just past plus the moment to come. In Lewin fashion behaviorally this equation could be transformed to:

$$bx = F(S^t) + F^1(S^{t-1}) + F^2(S^{t+1}) \qquad (4)$$

That is, a person's phenomenological field at any given moment is the present $[F(S^t)]$, the past $[F^1(S^{t-1})]$, and the future $[F^2(S^{t+1})]$.

Ordinary Differential Equations (ODE) did not really come in to their own as an analytical method until the mid-1960 when they were used to work on problems like understanding the energy function of clouds (Lorenz, 1963). Behavioral uses of ODE's did not begin until the mid-1980's (Strogatz, 1988).

Restated for Nonlinear Dynamics

An ODE recast of Lewin's initial field at a given time would look like the following.

$$B = S' + S'' + S''' \qquad (5)$$

A person's field consists of the present, past and future. The present, past and future are represented by ODE's S', S'', and S''', respectively. In ODE parlance, these are vector (vectors are mathematical expressions that have direction and magnitude) functions, each a linearity. As such each situation of linearity is deterministic in the sense an outcome can be calculated. The following will illustrate how a mathematical formula can be both deterministic and lead to multiple possible solutions.

CHAPTER 5

WHAT IS NONLINEAR DYNAMICS: A PRIMER ON ODE'S AND NONLINEARITY

Recall from the earlier description of ODE's (Ordinary Differential Equations) as nonlinear expressions or descriptions of human behavior. The mathematics of nonlinear dynamics is unlike any mathematics used in social science. The assumptions of experiment are so different from what is generally practiced in psychological labs and experiments, that a small explanation of the mathematics in necessary before beginning explicating nonlinear dynamics.

Mathematics is broadly defined as a science or group of related sciences dealing with the logic of quantity and shape and arrangement of mathematics symbols. In a sense, mathematics is the manipulation of symbolic variables that stand in for objects, shapes, things, or ideas. The notation used in mathematics represents a language of sorts. Programmers often refer to computational software as languages (e.g., COBOL, FORTRAN, BASIC, C+, etc.). Like all languages, mathematical functions have grammar, syntax, structure, and meanings.

Mathematics is composed of major elements beginning with foundational mathematics, which includes symbolic logic, set theory, and axiomatic logic. Next are algebra or counting, arithmetic, algebraic operations, and symmetry. After algebra is geometry from Euclidean to analytic geometry. Most of geometry is concerned with the description of real dimensional objects (2D or 3D). Next is analysis, which consists of calculus, integration, complex variables, differential and integral equations, complex functions, and numerical analysis. Calculus, integration, integration, and differential equations are concerned with the behavior of functions (simple and complex) in space (from 2D to N space). Next is probability and statistics. Inferential statistics is about how closely the data fits a given predicted line (usually linear). Finally we have computer and information sciences (software languages).

From a dynamical point of view, the origins of animal and human behavior could be expressed as a low-dimensional dynamical system (Kugler et al, 1980; Yates and Iberall, 1973). Of interest are the stable modes of behavior associated with attractors (positions in phase space where the behavior is relatively stable or stable point) and the transitions between these stable states associated with bifurcations (changes in dynamics or change point) in the organisms' system behavioral dynamics.

Dynamics is the study of system change over time (Acheson, 1997; D.W. Jordand and Smith, 1977; Strogatz, 1994). A way of representing a system change is the traditional time series which graphically plots the value of a variable as a function of time. Typically, over time, the variable could settle into a stable equilibrium, zoom into infinity, settle into a repeating pattern, settle into irregular chaotic, settle into a random pattern, or switch between any of the above patterns.

Generally, a system can be described by a set of variables (x1, x2,… xn) also know as state variables and its current location in state space defined by these variables. Behavior of the organism is characterized by changes in the state variables (the change in original state variable over time) and is represented by a trajectory in state space where time is implicit.

The objective of system analysis is to formalize the behavior of the dynamical system using a collection of first-order differential equations where the rate of change in each variable is directly related to the current state of the system.

$$S1 = f1(x1, x2, \ldots xn) \tag{6}$$
$$S2 = f2(x1, x2, \ldots xn)$$
$$\vdots$$
$$Sn - fn(x1, x2, \ldots xn) \tag{7}$$

Observed behaviors are represented by the solutions of these equations of motion for initial conditions and are presented as trajectories (routes to the ultimate end behavior) in state space. Small changes in initial conditions create an entirely different set of trajectories. Locations in state space in which trajectories converge are called attractors, while trajectories which diverge are called repellers.

Sudden changes in trajectory (Figure 3) are called bifurcations. By expressing the behavior of the organism using differential equations allows of the manipulation of variables and state spaces for a more complex understanding of the origins of behavior, its stabilities and instabilities, and the states that govern said behavior (Brown, 2006).

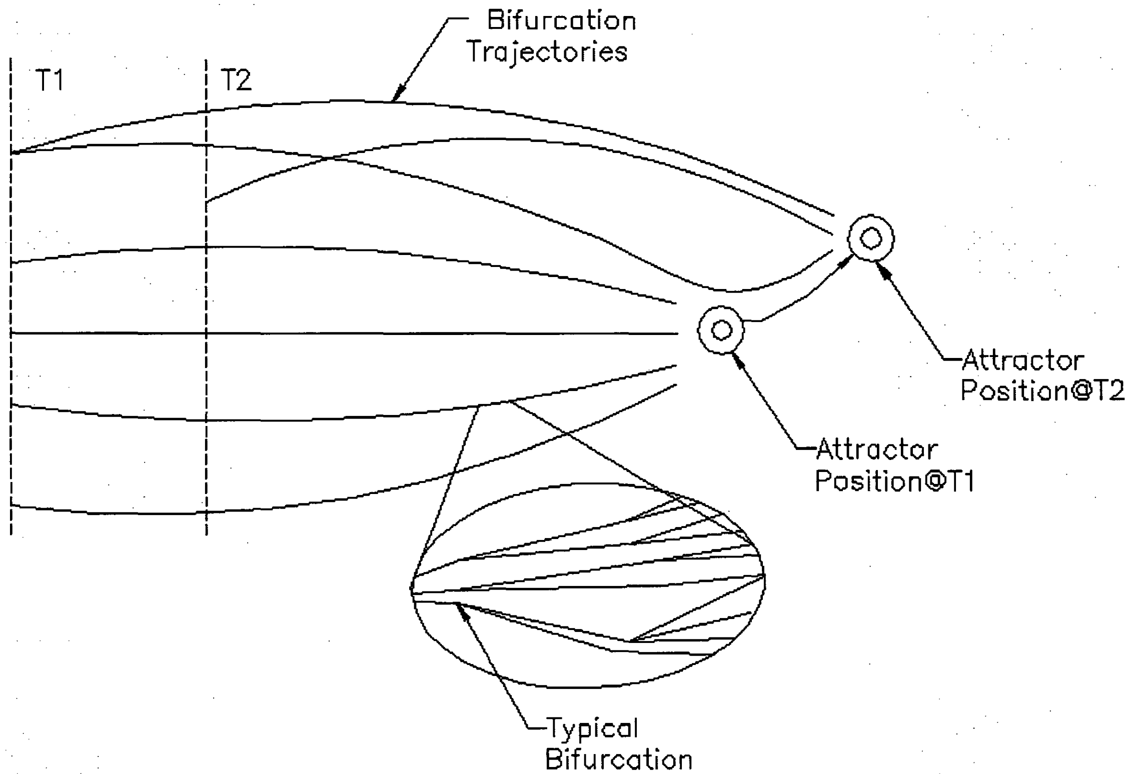

Figure 3. Attractors and Bifurcations

Dynamic systems are classified by their dimensionality (the number of state variables required to predict the state of the system) and their linearity (the number of nonlinear terms such as variables to the power greater than one and form products such a trigonometric functions or other unusual exponential variables).

Mathematics is "The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions and of space configurations and their structure, measurement, transformations, and generalizations." (Webster's,1973) While we could organize mathematics by its applications or by level of nonlinear, mathematicians prefer to organize the field by thematic lines. These thematic lines often resemble the course structures in many universities. For the purposes of this discussion, we will begin with the bare essentials: functions.

Functions essentially describe the behavior of something, be that the motion of a ball, the rise of temperature, or an emotional trajectory such as anger. Functions can be sketched to graphically describe any behavior or phenomena. A sketch is usually the first step in creating a model.

A function is a value associated with the interaction between 2 variables. One of the variables is the independent variable and the other is the dependent variable. The function is usually written thus:

$$X = f(x) \tag{8}$$

Where x is the independent variable and f(x) is the dependent variable. (For the purposes of this treatise, I will use the capital X for function designation. Another symbology is common for this designation such as y, f(x), etc.)

There are many other types of useful functions. For instance the most common type of function is a polynomial. These functions are expressed as sums of integer powers of a variable. The general form is $X=y=f(x)=a+bx+cx^2+dx^3.....+Kx^P$. Polynomials are used to describe almost any existing behavior.

Linear polynomials are polynomials of one degree and graphically appear as straight lines. Quadratic polynomials are second degree polynomials and graphically yield a curve that is called a parabola. Examples of parabolas are the curve of satellite dishes, flashlight or headlight reflectors, and the arc of water spouting out of a drinking fountain. Cubic polynomials are polynomials of 3 degrees and yield curves that are N shaped.

Other common functions are trigonometric functions (for periodic processes), exponential functions (for multiplicative or geometrically rising processes), and logarithmic functions (for the inverse of exponential processes and used in solving exponential equations).

The limit of a function is the value of a function or sequence when that function becomes asymptotic or when the function approaches a value beyond which the function cannot go further. Think of the limit as the upper value of a function where the function is useful in describing the behavior of a process.

Mathematicians often use a derivative as the limit of a function. The derivative is technically when the change is a rise of the function divided by the change in run of the function equals zero ($\Delta y/\Delta x=0$). Thus the since the change in the slope of the function can no longer be greater than zero, hence the limit is reached. The derivative of a function is often symbolized as X'. (Gottman, Murray, Swanson, Tyson & Swanson, 2002)

The most common function seen is a straight line, where the X is a function of x and the function is proportional. It is often commonly thought to be linear in nature (straight line). The graph of this function is a sloped line. Thus statistics, which measures the deviation from a predicted line is a form of linear thinking.

One-Dimensional Linear and Nonlinear Dynamics

One-Dimensional equations are equations of two variables, the independent variable and the dependent variable. An example of this is a mechanical system such as a stream of air. The movement of a particle of air would be governed by the equation 2.

$$X=x^4+5x^3-8x+237 \quad (9)$$

In equation 2, X= the height of the particle and x= the distance traveled. So for x=2, X would be 277. To get an idea of the trajectory of the particle, one could plot the value of X for every x. The plot would look like a wavy line that moved from x=0 to x=∞. This is an example of a polynomial as a description of the movement of a particle.

Differentiating equation 1 yields the velocity or rate of change of equation 2.

$$X'=4x^3+15x^2-8. \quad (10)$$

This is called a first order linear differential equation. It is considered a first order equation because the order of a differential equation is the highest derivative that appears in the differential equation. In this case the highest order is 1 (for '). The degree of a differential equation is the power of the highest derivative term. In this case the highest power is 3 (for x^3).

So what is the difference between linear and nonlinear differential equation. A system can be considered linear if the satisfies both superposition (if $y_1(x)$and $y_2(x)$are solutions, then so is $y_1(x)+y_2(x)$) and homogeneity (terms used must be in the same dimension). These conditions can be expressed by the following equation property.

$$f(a_1x_1+a_2x_2)=a_1f(x_1)+a_2f(x_2) \tag{11}$$

Otherwise, the differential equation is nonlinear. A simpler way of considering an equation linear is if all the inputs are proportional to the outputs. If they not, then the equation is likely nonlinear.

Now consider a typical first order nonlinear differential equation.

$$f(x') = \sin x \tag{12}$$

The equation graphically looks like this (Figure 4).

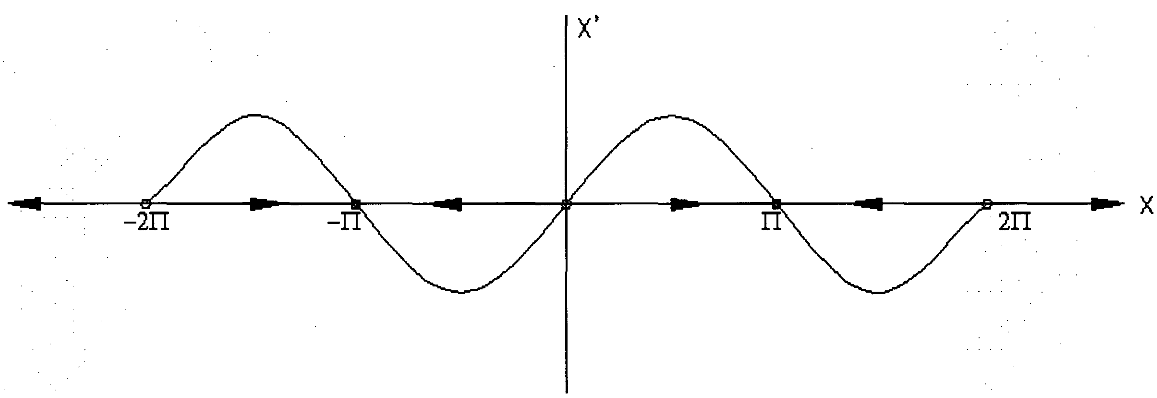

Figure 4. Nonlinear Sinusoidal Plot

Notice this is field that is defined in two dimensions, x and x′ respectively. This is called a vector field of the line because it has direction (as defined by 2 dimensions) and magnitude (as defined by the value of the equation). Further, think of this as an imaginary creek steadily flowing along the x-axis with the line [5] representing the speed (velocity) of the creek at points along the creek. As shown in the figure above, as the flow approaches π notice the flow velocity approaches 0 (that is the function $x' = 0$) and when the flow approaches 2π the flow moves away from 0. Where the flow is 0 are called fixed points. There are two kinds of fixed points, where the flow is approaching and where the flow is moving away. These are called attractors or sinks and repellers or sources. The former is considered stable and the latter are unstable.

Also the figure implies other definitions that will be useful when evaluating higher order nonlinear situations. For instance, if the function begins at some arbitrary point significantly far from $x = 0$ in either direction, this point is known as a phase point. Its movement along the function is called the trajectory based on the initial phase point. The picture of the function is called a phase portrait.

Finally, a notation about equilibrium, equilibrium (or steady state, constant, or rest positions) is stable if all small disturbances away from equilibrium are dampened out in time and represented by stable fixed points. Thus unstable equilibria are points where small disturbance away from that point are not dampened out and are represented as unstable fixed points.

Bifurcations

Bifurcations are abrupt changes in function values. In dynamic systems bifurcations are the critical points of interest. For the most part dynamic systems operate unobstructed in the direction of flow until a bifurcation is encountered. From a psychological point view, bifurcations are points in the neuro-processing where changes in behavior (decisions or emotions) can be noted observed and reported. The points where bifurcations take place are called bifurcation points. Bifurcations are where transitions and instabilities occur as control parameters are varied.

In one-dimensional linear dynamics there are three types of bifurcations: saddle-point, transcritical, and pitchfork. A fourth type of bifurcation occurs in nonlinear dynamics: Hopf bifurcations.

Saddle-Point Bifurcations

Saddle point bifurcations (also known as fold bifurcations, turning bifurcations, point bifurcations, etc.) are where fixed points (equilibrium solutions) are created and destroyed as parameters are varied.

At saddle-point bifurcations, the function is varied across a fixed point. As the function approaches a fixed point, the values of the function close in on that point and eventually destroy or annihilate the point. As the function moves away from the point the point is created. (Figure 5)

The typical equation for a saddle-point bifurcation is:

$$X' = rx - rx^2 \qquad (13)$$

Where X' is called the vector field, and the entire equation is also known as the logistic equation (Figure 6). In psychological terms the logistic equation could be considered a behavioral process equation.

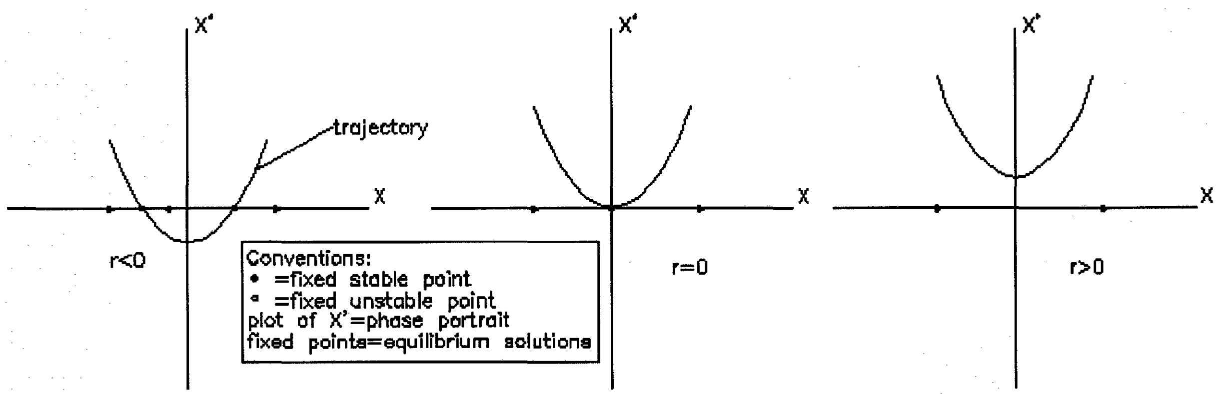

Figure 5. Saddle Point Functions

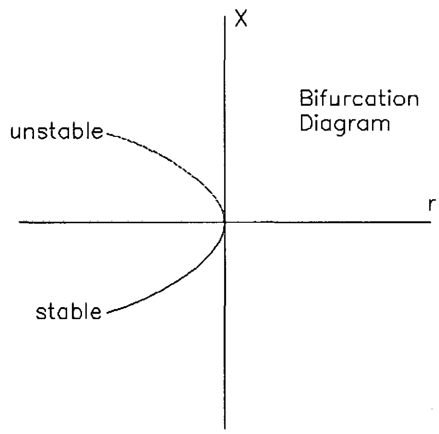

Figure 6. Saddle Point Logistic Diagram

Note that for saddle-point bifurcations, the movement of r is in the direction of x' (Figure 6).

The nearest analogy for saddle point analysis is Kelso's notions of progressive movement of the arm while throwing a ball. The progressive diagrams of the saddle point diagram describe the movement of arm and shoulder while during throwing action.

Transcritical Bifurcations

Transcritical bifurcations are where fixed points exist and are never destroyed. However the stability of the function varies. Typically the logistic equation remains fixed and stable until a certain point in the process, where the function stability varies as the function process continues. A typical physical application would be a solid state laser. The typical equation for a transcritical bifurcation would be (Figure 7):

$$X' = x^2 + rx \tag{14}$$

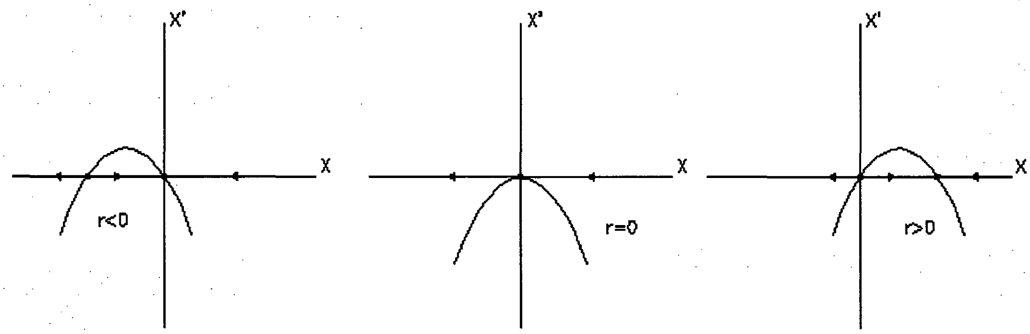

Figure 7. Transcritical Bifurcations

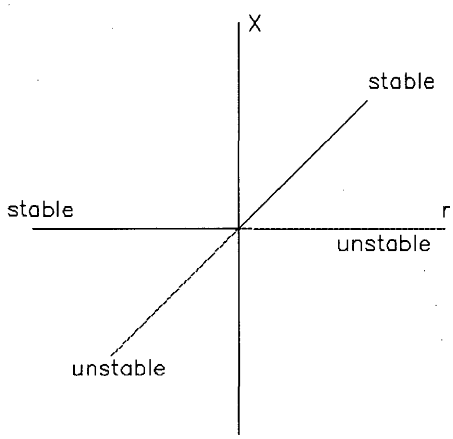

Figure 8. Transcritical Logistic Diagram

Note for transcritical bifurcations the movement of r is in the direction of x. Since the transcritical bifurcation switches between regions, this might be a possible equation to evaluate bipolar behavior (Figure 8).

Pitchfork Bifurcations

Pitchfork bifurcations are where fixed points tend to appear and disappear in symmetrical pairs. There are 2 types: supercritical and subcritical. Pitchfork bifurcations are for processes that display symmetry.

Supercritical (also called forward bifurcation, similar to continuous or second order phase transition in statistical mechanics) bifurcations provide soft or safe solutions in engineering problems. The equations are invariant. That is substituting -x for x yields the same equation (also known as equivariant). The prototypical equation is (Figure 9):

$$X' = -x^3 + rx \tag{15}$$

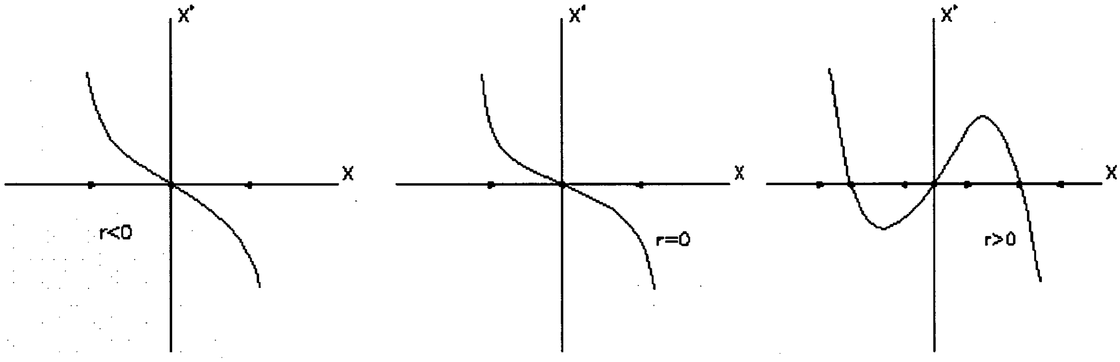

Figure 9. Pitchfork Bifurcation

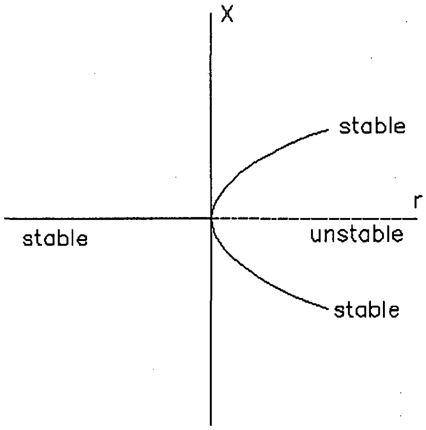

Figure 10. Pitchfork Logistic Diagram

For r<0, only one fixed point, and process is stable and predictable.

For r=0, still one fixed point, process is stable, predictable, more weakly [called critical slowing down].

For r>0, the one fixed point has become unstable, 2 stable points emerge, process is unstable, unpredictable. (Figure 10)

Subcritical pitchfork bifurcations (also called inverted or backwards bifurcation), similar to discontinuous or first order phase transitions) are usually unstable (Figure 11). Engineers refer to these solutions as hard solutions). The prototypical equation is:

$$X' = x^3 + rx \qquad (16)$$

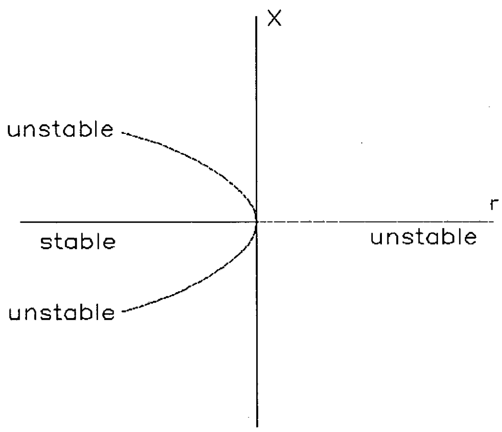

Figure 11. Unstable Pitchfork Logistic Diagram

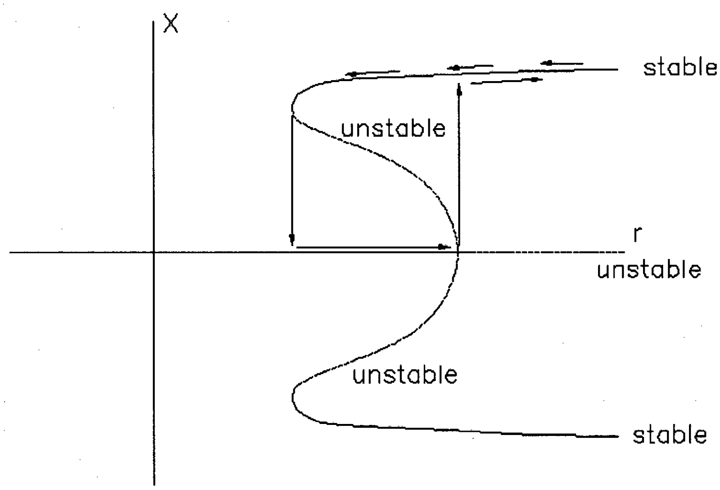

Figure 12. Pitchfork Stable and Unstable States

For r<0, no fixed point, all points exist below x=0, are thus unstable and thus subcritical.

For r=0, one fixed point at 0.

For r>0, points tend to explode outward, that is as r goes to infinity, x goes to infinity faster (Figure 12).

Imperfect Bifurcations (Catastrophes)

The process function is in the form of

$X' = x^3 + rx + h$ (17)

H is called an imperfect parameter (Figure 13). When h=0 the function becomes a normal pitchfork bifurcation. When the logistic equations for h>0 and h<0 are plotted, the functions meet at a point. The point is called a cusp point. The plot of this is called a stability diagram. Plotted in 3 space (r,h,x) the cusp point looks like a fold in space. This availability of dual values across the fold is called a catastrophe (Strogatz, 1994).

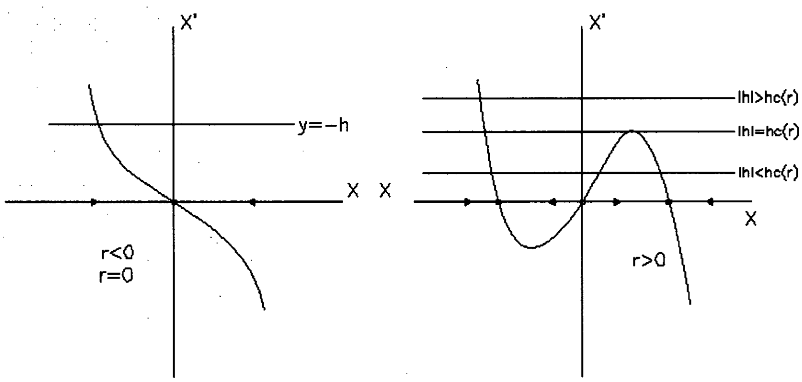

Figure 13. Catastrophe Bifurcation

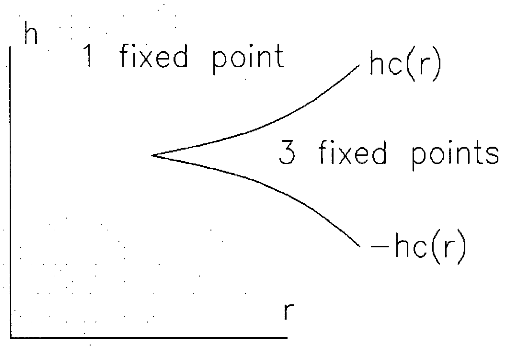

Figure 14. Catastrophe Phase Diagram

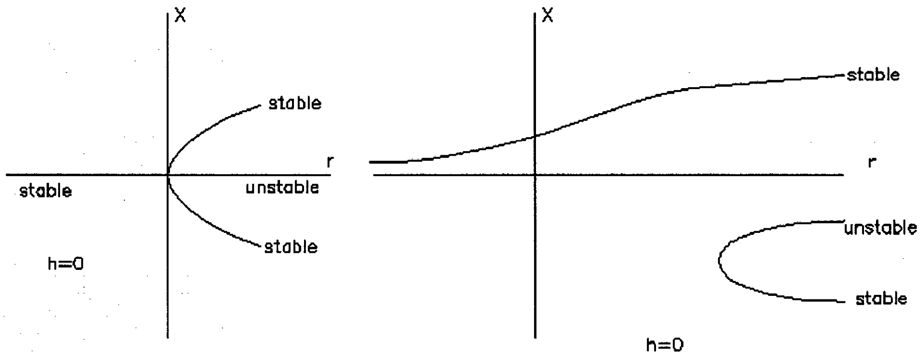

Figure 15. Catastrophe Logistic Diagram

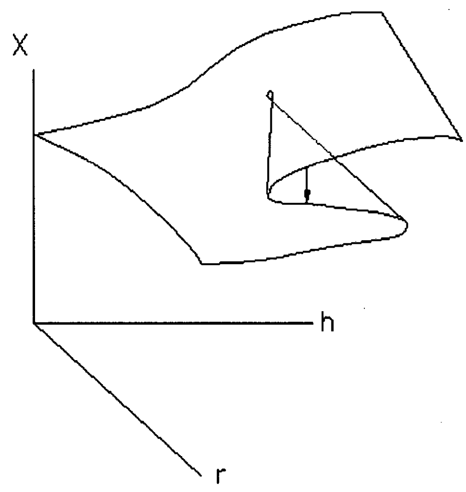

Figure 16. 3D view

The value of imperfect bifurcations is that these conditions allow experimenters the opportunity to devise experiments of two values. This a convenient position to develop bi-value factors for psychological exploration of conditions. Gottman et al took advantage of these imperfect conditions when he used a similar system to describe the behavior between a man and his wife (Figure 16).

Two-Dimensional Linear Systems

Two-dimensional systems are very complex. It is easy to get lost in the mass of equation processing. Their inherent nonlinearity does not lend to formulas with much insight as to the cause and effect. It is often better to try to understand these processes from the qualitative behavior of the systems. The goal is often to get the phase portrait from the properties of X′ directly.

The salient properties from most phase portraits share similar characteristics. The fixed points are where X′=0 and correspond to steady states or equilibrium points of the system. The closed orbits are periodic solutions that are time dependent and will change or dissipate over time. The arrangement of flow is near fixed points and closed orbits, and the stability or instability of the fixed points determines the flow nearby trajectories, to or from.

Chaos and What's not Covered

Our introduction to chaos is the famous butterfly plot as proposed by Lorenz (1963). Lorenz proposed a series of 3 equations for a simple model of convection rolls in the atmosphere (thermals for those do soaring).

$$S' = \sigma(y - x) \tag{18}$$

$$Y' = rx - y - xz \tag{19}$$

$$X'=xy-bz \quad (20)$$

It turns out that the simple equations yield a system that is deterministic (calculable) that produce erratic dynamics (unpredictable results with little change in initial conditions). When the plot of the 3 equations is created in 3 dimensional form, the attractor is not one of fixed points or limited cycles. Instead the attractor is not a point nor is a curve. It is instead what was then called a fractal.

Another way of visualizing chaos is through difference equations, iterated maps or just maps. These belong to a class of dynamical systems called discrete (vs. continuous). These maps are useful for analyzing differential equations, models of phenomena, and simple examples of chaos. An example can be found on page 21 of Kelso.

This is not an exhaustive explanation of nonlinear dynamics. Many topics were skipped in the interest of simplicity and time. Among the more important issues were limit cycles, partial differential equations, eigenvalues, hopf bifurcations, oscillators, stability analysis, existence and uniqueness, Poincare-Bendixson theorem, and Liapunov exponents.

CHAPTER 6

HUMAN INTERACTION EQUATIONS

The above mathematical discussion begs the question what would a human interaction equation be? Gottman et al (2002) uses a chaos model for the interaction between two individuals. The model may be suitable for any interaction between two persons.

Gottman et al (2002) original equations are:

$$W_t = W_s+w_t \quad (21)$$

$$H_t = H_s+h_t \quad (22)$$

Where variables (W,H) represent Wife and Husband engaged in an interaction. Where (w,h) represent perturbations in conversational form. Under steady state conditions (W_s,H_s) a small perturbation is done. The resultant is (W_t,H_t) which represent the change at "t". In the simplest form these equation describe changes in emotional state of a person engaged in an interaction. These equations state that a person a rest (W_s or undifferentiated state) is perturbated(w_t) and is consequently energized to another state(W_t). The mathematics beyond the initial set up is too complicated to be presented is this type of paper.

The data Gottman (2002) used for these equations are graded observed reactions and actual words used in interactions. For the above equation setup to used for any human to human interaction addition data sets needs to collected and developed on facial features and tone of voice so that whole data set will represent most of the important features of human interactions.

CHAPTER 7

NONLINEARITY AND ITS CHARACTERISTICS

Nonlinear equations constitute a sub branch of differential equations (ODE). Nonlinear equations are characterized by simultaneous states, settling states (basins of attraction), and different views of functions in different spaces, parallel processing (interation), and sensitivity of extremely small changes on initial inputs (Peitgen, Jurgens, and Saupe, 1992).

Two major features of nonlinear equations are attractors and bifurcations. These are both fixed points on the line or 3D object describing a process (e.g., chemical reaction, biological activity, cognitive process). However, what is dynamically happening around the attractor and bifurcation points are the differences (See Figure 3).

Attractors are points on the process where the process is being created or destroyed. Typically created points are symbolized by blackened dots and destroyed points are symbolized by small open dots. Bifurcations are the dynamics in and around these points. Bifurcations should be considered the process dynamics in and around the attractors.

From a therapeutic view, the attractors (often called basins of attraction) are what is figural in a patient's field and the dynamics (also called processes) that create, maintain, and destroy the basins of attraction are the emotional and cognitive processes that create, maintain, and destroy behavior.

Think of the attraction and figural process as a behavioral process described by the following equation.

$$\text{Behavior} = \frac{\text{Phenomenology}}{\text{Person}} \times \frac{\text{Context}}{\text{Ecosystem}} \qquad (23)$$

Nonlinear Dynamics may be useful for understanding the characteristics of complex systems (brain behavior processing). Guastello (1995) posits complex systems have 3 characteristics.

1) Complex systems display patterns that are not predetermined. That is the pattern is not always evident given a set of conditions.
2) Complex systems display patterns that are not exactly duplicable. That is, the pattern cannot be replicated exactly every time; tiny changes are always present.
3) The pattern of behavior cannot be predicted.

Zeeman (1976) posits the behaviors associated with nonlinear dynamics include

1) Either-or thinking (bimodality). We have seen this in clients that cling to either-or thinking. These individuals cannot see the gray between positions, on the positions themselves.
2) Sudden changes in behavior (sudden transitions). Again, we have seen this kind of behavior in clients. The seemingly arbitrary jump from one behavior to another without any warning or hint of the change. This often followed with no particularly rational reason, either fabricated by the left hemisphere or irrationally created on impulse elsewhere in the brain.
3) Different motivations for one direction of thinking than for the opposite direction (hysteresis). The strength of reasoning for making a decision in one direction may be more or less than the strength for making the same decision in exactly opposite direction. That the motivation is uneven in decision directions.
4) Low probability behaviors occurring for given situations (inaccessibility). We are often surprised

by the decisions that seem to come out of the blue for no particular rhyme or reason.

5) Small changes in situations producing exaggerated responses (divergence). Of course, we have seen this behavior in certain patients who are predisposed for certain personality disorders.

A quick inspection of the above list brings to mind the some of the complexities of doing therapy with clients. This makes sense considering the mind is composed of 10^{14} connections. This means the number of permutations of combinations is nearly infinite (Kelso, 1995). Kelso in his ground breaking article on nonlinear dynamics and hand to eye coordination argues from the neurons to the brain itself, the components or the major systems, all behave in a nonlinear dynamic fashion. "The linkage between coherent events at different scales of observation from the cell membranes to the cerebral cortex is by virtue of shared dynamics, not because any single level is more or less fundamental that any other virtue" (Kelso & Tuller, 1984). Kelso is arguing that chaos is the currency of brain in mass action. While study of the individual brain components or event the study of brain regions, it is the interaction of large parts of the brain that brings nonlinear processes into action. Freeman (1991) posits, "Chaos underlies the ability of the brain to respond flexibly to the outside world and to generate novel activity patterns including those that are experienced as fresh ideas (p78.). Further, Kelso (1995) posits that," self-organization, the spontaneous formation of spatiotemporal pattern that emerges under open conditions, is hypothesized to act on many scales of observation". What an observer sees as one aspect of hand to eye action will appear different to another observer.

Complex systems go by many names: chaos, nonlinear dynamics, nonlinear dynamical systems theory, and self-organization. Physics (Gleick, 1987), chemistry (Kauffman, 1993), and biology (Stewart, 1989) were among the first sciences to recognize nonlinear dynamic solutions matched the data for complex problems. Nonlinear dynamics is about how systems change (Morrison, 1991).

Nonlinear dynamic psychological process can be classified as both linear and nonlinear. That is, the function can be a straight line or a series of interrelated functions. Nonlinear solutions have different graphical qualities in different space. That is the functions are non-orthogonal. That is these processes are not at right angles to each other or in the same field and meet a common point at right angles to each other. Linear dynamics are characterized by a combination of 2 or more linear equations that provide a linear solution (Morrison, 1991; Stewart, 1989). Typically these equations work well for most problems in the physical world (number of variables = number of equations). Typical problems would be calculating the static load carrying capacity of a bridge or determining the voltage output of a circuit or in the case of husband and wife dynamics (Gottman et al, 2002). It is also the basis of statistics like regression analysis, ANOVA's, and statistical power (r^2). The principle limitation of linear dynamics is its inability to describe what happens in natural systems (ecosystems, weather, and human behavior). The most difficult problem for linear dynamics is when something happens suddenly (discontinuities) and abruptly like when we change our minds about buying something or when there is a change in synchronous finger tapping when the rate exceeds a certain point (Kelso & Schoner, 1988). The better solution to such problems is nonlinear analysis of patterns.

The processing creates these patterns by iteration. That is the output of the nonlinear equation becomes the input for the next pass at the equation. Parallel processing on a huge scale can do this efficiently and quickly; more efficiently and quickly than in serial processing (processing one equation at a time). The result is a pattern of equations that settle or converge on a position or attractor.

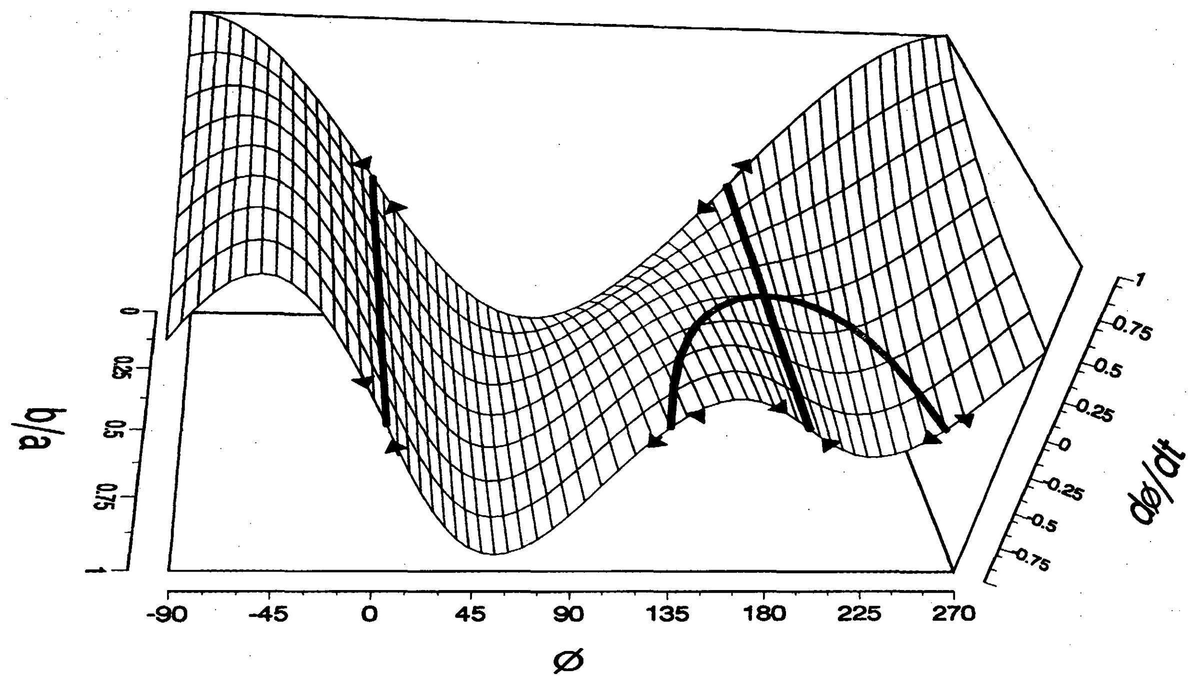

Figure 17.HKB model of coordination expressed as a vector field (Kelso, 1995)

In figure 17 is the Haken-Kelso-Bunz (HKB) model of coordination (Haken, Kelso, & Bunz, 1985). Using the ordinate coordinate system, the length, Φ, represents relative phase change, from -90° to 270° (which is the relative difference and change between the shoulder and arm expressed in absolute angles). The depth, b/a, represents "b" and "a" variables in the equation and are experimentally determined and based on the individual kinetic qualities of movement. The height, $d\Phi/dt$ is the change in Φ over time. The HKB model describes the brain control of hand movements. They begin with a function, V, which describes regularly repeating hand movements. That is, the hand motion can be described by a function that shows the regular movement to and from in relation the angle of movement. Such an equation is $V = -(a)(\cos\Phi) - (b)(\cos 2\Phi)$. This function allows the observer to follow the hand movement from 90° left movement to 180° right movement as shown at b/a=1. The function at that time resembles a double trough with the right hand movement amplitude lower than the left-hand amplitude. (This represents the coordination between two hands, say in trying to two hand launch a basketball to the net.) This is called a pitchfork bifurcation. Note that in this type of bifurcation, the pathway is multistable at two dwell or low points. If the processing is less than 1 nanosecond, which surely it is, the next multistable point is virtually indistinguishable to the human sensory system.

The reason the coordinative process represents a region of solutions is that animal coordinative systems are rarely identical in component constituents. Arms are of different lengths in individuals, muscle tone is different between persons, and coordinative experience differs between persons (some can throw a ball with accuracy and others have little practice).

As the system continues to process, around b/a, the process transitions through a phase change were the pathway is no longer multistable. As the processing continues, a final stability will be reached. That point is called the basin of attraction. The entire process may take from a few nanoseconds to a few microseconds. Recall that attractors are points in the dynamics where processes are created or destroyed. Other examples of dynamics where basins are created or destroyed are choosing colors of clothes, processing strong emotions, or throwing a baseball.

Figure 18 below shows one of many typical types of behavior. They are examples of settling into a discrete point, behaving in an oscillating cycle, developing into a quasiperiodic cycle (torus), and a chaotic cycle.

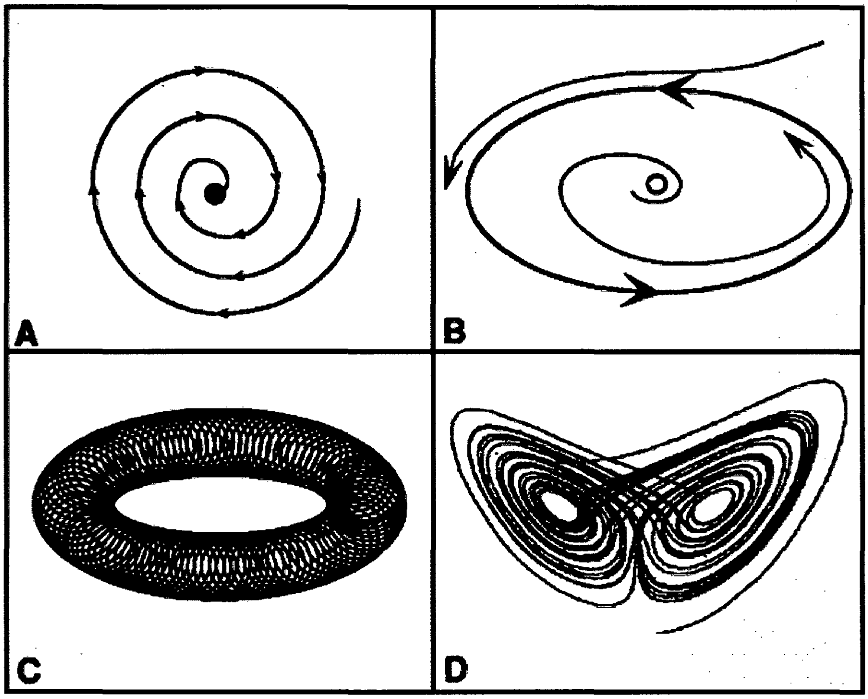

Figure 18. Types of basins of attraction (Barton, 1994)

In the case of the chaotic attractor, the pattern behaves like other attractors until a number of cycle's lapse. At that point the cycle becomes unstable and irregular. This class of attractor while deterministic, becomes irregular because of the structure of the equation that drives this process. Chaotic attractors are dependent of the initial conditions. If the initial conditions are different by just a small almost minute amount, the outcomes will diverge into 2 entirely different solutions.

This is the definition of a self-organizing system. Self-organizing systems originate in open systems when patterns emerge without input from external (environmental) sources. These systems become unstable or multistable upon an increase in the minimal energy to drive the system past a critical threshold. In biological systems the external sources such light and sound are processed through the organism's sensory organs. These organs provide additional inputs to the nonlinear process.

Since the development of the mathematical tools to evaluate nonlinear dynamics, a number of researchers have begun the process of pioneering the basic application and methodology. For instance, in the areas industrial psychology work has been completed on employee morale and absenteeism (Sheridan, 1985; Sheridan & Abelson, 1983), industrial accidents (Guastello, 1988), collective bargaining (Olivia, Peters, & Murphy, 1981), conflict avoidance (Abraham, Abraham, & Shaw, 1990), goal setting (Hanges, 1987), and performance appraisal ratings (Hanges, Braverman, & Rentsch, 1990). In the area of psychological and biological systems process related to change and development many researchers have provided foundational research such as Hufford, 2001; Schuldberg, 1999; Haynes, Blaine, & Meyer, 1995; Ehlers, 1995; Vallacher & Nowak, 1994; Combs, Winkler, & Dailey, 1994 and Waldrop, 1992. Additional work has been done by Lavine & Fitzgerald, 1992;

Vandervert, 1991; Sabelli & Carlson-Sabelli, 1989; Skinner, 1989; Odum, 1988; and Jantsch, 1980. In the areas of physiological psychology work has been begun on figure perception (Stewart & Peregoy, 1983; Ta'eed, Ta'eed, & Wright, 1988), memory formation (Freeman, 1990, 1991; Kohonen, 1988), attention and electroencephalograms (Basar, 1990), coordination (Turvey, 1990) and conditioning in animals (Hoyert, 1992). In the area of developmental psychology work has been completed in the areas of cognitive development (Saari, 1997), learning (Carpenter & Grossberg, 1987; Hanson & Olson, 1990), infant postural control development (Boker, 2001), and adolescent alcohol use development (Clair, 1998). In the area of clinical psychology work has begun on the areas of bipolar patient self-ratings (Gottschalk, Bauer, & Whybrow, 1995), sleep dynamics (Roschke & Aldenhoff, 1992), self-organization and the psyche (Marks-Tarlow, 1999); and marital therapy-family systems (Elkaim, 1990, Gottman, 2002, 1993). In the area of clinical research into Nonlinear Dynamics and the area of psychotherapy work have begun.(Goudsmit, 1989; Reidbord & Redington, 1992), and psychopathology (Guidano, 1991; Putnam, 1988)

Field Theory Revisited

Lewin's field theory can now be viewed in a modern context. Lewin's notion of field is experiential or phenomenological (Lewin, 1951). That is, each of us as an individual, possess' an experiential field. This field is the way an individual looks and receives the world around them. It is the portal through which all is gathered. The field is ever changing in response to the stimuli present at the moment. The field addresses the person's needs and desires as well as the content of the person (sickness, learning, information, experiences, etc.). The field is first and foremost what is sensorily perceived by the person; what is seen, what is tacitly felt, what is touched, what is heard; all the sensory input receivable by the person. Since the field is responding to what is in the moment, the field is context dependent. Hence no two individuals have the same field as the other.

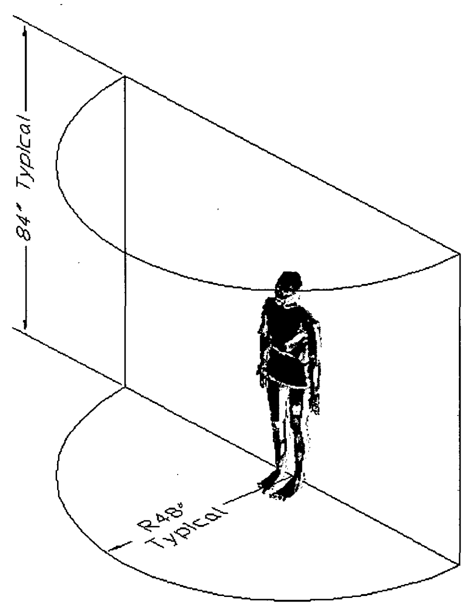

Figure 19. Individual field at time T=0

There is an analogy used in physics. Physicists create theory and solve problems using what is called a control volume (Streeter, 1958). The control volume is an imaginary volume surrounding the phenomena of concern. Physicists measure what goes in and out of the control volume and try to surmise what happens within the control volume based on the data collected. From the data, physicists create models (often mathematically based) of what goes on in the control volume. They then apply this model to similar control volumes and manipulate the inputs to predict the outputs. If the outputs match what the model predicted, then they conclude that the model of internal behavior is correct.

Psychologists' use a similar technique. Psychologists' observe the sensory, cognitive, and behavioral inputs and outputs. They calculate statistical relationships between inputs and outputs to see if these variables meet a statistical threshold (<. 05) in order to declare a relationship between the variables. In a way the statistical measurement of variables is a global way of measuring a psychological control volume.

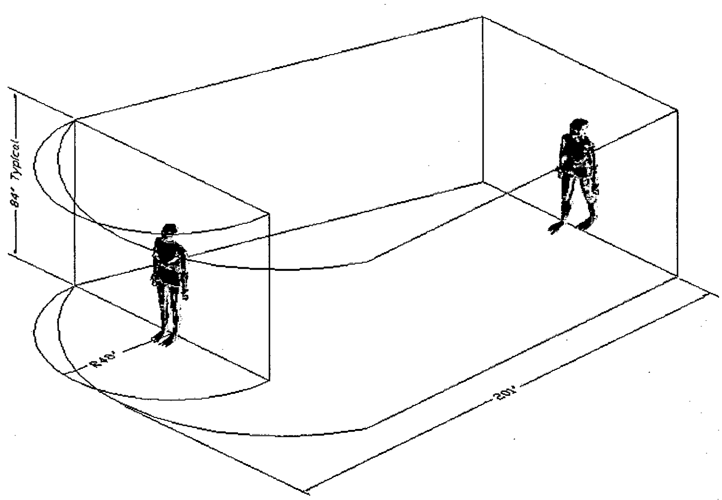

Figure 20. Overlapping fields of two individuals, one who is not aware of the other at T=1

The patient's field or control volume includes all that is within the organism's field of experienceable perception, material or subjective or available to awareness. To denote the difference between the physicists' notion of field and the Gestalt notion of field an "Efield" is an experiential field, or psychological field. The Efield encompasses all that can be sensed, thought about, and to wit responded. The field changes moment to moment because the organism is constantly receiving and processing stimuli inputs.

While the organism is part of the e-field, there is another field that the organism maps to. This field is not phenomenological in nature. Rather is more physical in nature.

From a nonlinear dynamic perspective, the minute iterations between the Efield of the organism and the surrounding inputs constitutes the minute inputs into the brain equation system that yield the different deterministic and unpredictable responses the organism produces to the situation at hand.

The interaction between the Efield of the organism and the surrounding environmental field is the heart of the phenomenological process of gestalt therapy.

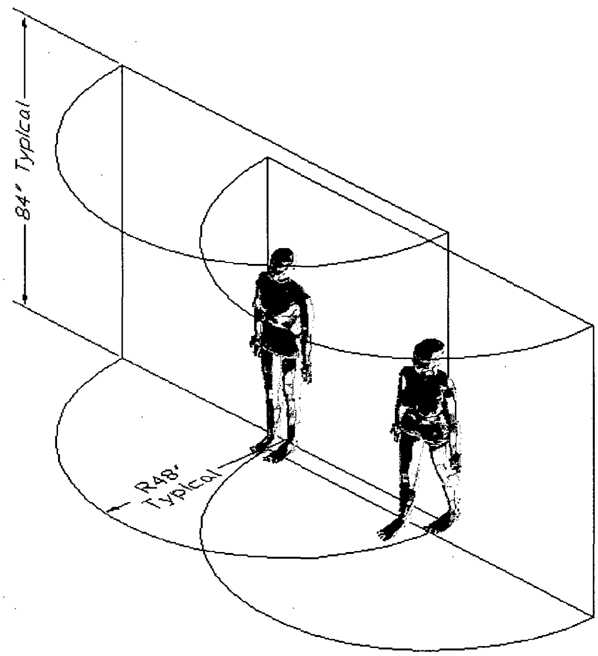

Figure 21. Overlapping fields of two individuals as both become aware of each other at T=2

As therapists, we are interested in how a person's Efield is organized, what in the Efield is recognizable, what does the Efield respond to, etc. As therapists we examine the Efield, its size, what is in the Efield, what are the relationships in the Efield, all the details of the Efield, small and large and patterns of processing?

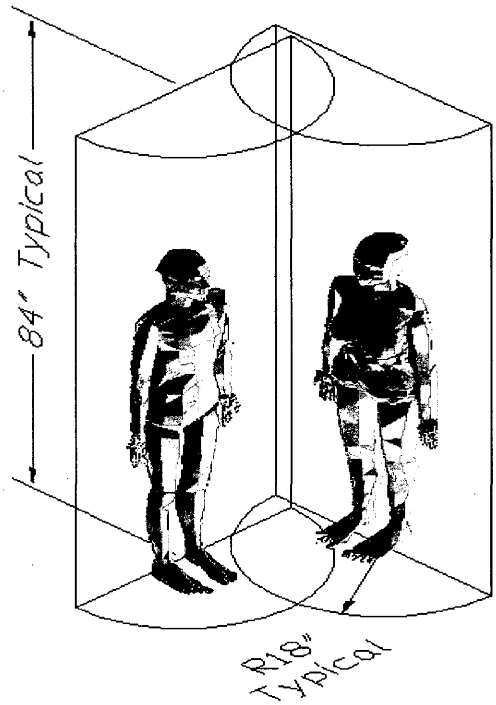

Figure 22. Overlapping fields to two individuals who become engaged in conversation at T=3

The therapist try's to examine the patient's Efield, so as not to disturb the field. Just as in physics, the Heisenberg (1930) Uncertainty Principle applies. Just the act of observing subtly influences the field. So, the examination is done with approximate objectivity. Therapists make efforts of do so mindful of their own prejudices. Individuals take in the data, all the data, from the minutest bit of observation to full observation of the field as a whole. Persons do so in the present, fully in the here and now. This data gathering is done by primarily through dialogue with focusing on the patient's phenomenological features, gestalt experimenting, spontaneous patient self-disclosure and observation of behavioral features.

The Efield is subject to any disturbance. From a computational neuroscience viewpoint, those disturbances are the input variables for the bifurcation equations found in brain processing. These inputs (internal and perceptible external) provide macro information about the environment. The micro information is contained in the phenomenology of the brain.

Orsucci (2001) has proposed this examining of the Efield to be synchrony. That is two Efields in synchrony when two individuals engage in a deep conversation. The synchrony between Efields is maintained by small perturbations (i.e., strategically small responses). So, in the process of making therapeutic contact, one observes the usual physical indications of a good connection (e.g., eye contact, head movements acknowledging points, facial features suggesting interest) and also synchrony in the conversation in the form of small strategic comments.

Phenomenology

Phenomenology is about awareness. "Insight is a patterning of the perceptual field in such a way that the significant realities are apparent; it is the formation of a gestalt in which the relevant factors fall into place with respect to the whole" (Heidbreder, 1933, p. 355). Husserl (1931) defined phenomenology as "Phenomenology, 20th-century philosophical movement dedicated to describing the structures of experience as they present themselves to consciousness, without recourse to theory, deduction, or assumptions from other disciplines such as the natural sciences. Husserl was interested in the reflection of the content of what the person was thinking." Husserl called this type of reflection the phenomenological reduction. Because the mind can create what is real and not real, Husserl thought the phenomenological reflection does not suggest something exists. Instead the reflection represents "bracketing of existence." That is, the ignoring whether a subject really exists or not.

Husserl suggested that the content of the mind were acts of remembering, perceiving, desiring, and abstractions of the content. He called these meanings. These meanings were directed toward an object and were called intentionality. He thought this was the essence of consciousness. Heidegger (1927) thought phenomenology would reveal the hidden in everyday experience and he called this "being-in-the-world.

Phenomenology is in part focused on how people organize meaning. Phenomenology organizes the ground. Phenomenology also is interested in how patients create behavior from their past experiences. All experience is thus fair game for the therapist. Phenomenology suggests that a person can only know that which the person experiences (Husserl, 1931).

From a nonlinear view, bifurcations represent the emotional and cognitive processes taking place. The specific dynamics or processes determine the trajectory of thought and/or emotion. As therapists it is these processes or bifurcations that we are interested in understanding and bringing the awareness of the client.

Figure/Ground

As we experience the events of life, a prominent "figure" emerges from the environment to catch our attention. This is organized against the psychological field or "ground." This notion comes from the gestalt theory of perception (Kohler, 1947). The figure contrasts against a plain, formless, infinite ground (Polster and

Polster, 1973).

The ground includes sensation, working memory, STM, and LTM (episodic, semantic, and procedural) as well as iconic and echoic memory and all of life's experiences. The ground provides context for the figure. Without this context no meaning can be generated. As a figure emerges from the ground, it draws attention for a varied, finite, length of time. Eventually it recedes because of completion or competition from another figure. When the figure recedes, successful reintegration makes for a new meaning.

From a nonlinear perspective, what is figural is the attractor generating the most energy. The size and power of the mathematical function associated with the emotion (limbic response) might represent this. This attractor stands in high contrast with other attractors being process at that moment. A graphical solution might show many attractors in the field, however the best attractor for the organism will be the largest and strongest attractor, mathematically.

Contact

Contact happens across the boundary between and within organisms. The boundary layer consists of the area subsumed by the range of sensory organs including sight, hearing, taste, touch and association areas of the brain. These are the areas that we humans experience life's stimuli (Perls, Hefferline, & Goodman, 1951).

Not only is contact a boundary an external issue (although from a therapeutic view, it is the contact area most likely to be explored), contact occurs at all boundaries within the organism. The awareness of contact of the boundaries of your own organic sensations and, sometimes even at the cellular level, constitute a form of contact. A contact of this level might be the queasy feeling one gets from bad food. Here the contact is between various internal biological systems that yield sensations that suggest something is not well with something inside of your body. Not only are these types of sensations "contactful", but any sensation that seems out of place during the dialogic process. The awareness generated by contact is both sensitive and off kilter.

Contact occurs across the interface between fields between organisms or an organism and its field. It is reflection of the neuro-processing that occurs when there is recognition of a disturbance or perturbations in the field.

Contact allows the organism to regulate across the boundary. The processing is without predetermined outcome. Hence it is a creative process. From a computational neuroscience perspective, the nature of contact is bounded on one space by the habitual attractors already present and bounded on another space by what creative processing may be triggered by a series of bifurcations. In an ideal world these interact with each other to form new awareness.

Contact in a greater gestalt sense is the interface between any boundaries that is within the Efield.

Resistances (Bounding anomalies)

Practitioners of Gestalt therapy look upon symptoms or defenses as attempts to solve a problem (what is figural) usually through habitual but a contextual adjustments. The original solution may have fit well. Over time things change. The original solution becomes embedded in memory and is over learned. The solution thus becomes part of procedural memory (Tulving, 1985; Burley & Freier, 2003). The same solution now may be inappropriate and be just is a bad fit or the organism may be just too lazy to overcome the procedural memory and figure out a new process. These responses to this change condition fall into 5 patterns. These patterns (resistances) include projection, retroflection, introjection, confluence, and egotism. Gestalt therapy tries to bring these resistances into awareness. The objective is to develop a better self-regulating response (Wheeler, 1991).

When an organism deploys resistances, the organism is trying to avoid facing what is figural. It is form of resistance to change, denial.

From a nonlinear dynamics viewpoint, resistances reflect attractors that have not adapted to changing inputs. These attractors have become habitual and represent a lack of creativity in developing a range of attractors. In some ways, the organism gets stuck in the loop, going round and round with little forward progress toward a creative and appropriate solution. Clinicians are all too familiar with this behavioral pattern.

One can think of therapy as coordination between two complex vectors, emotion and logic. Most experienced therapists would regard pure use of cognitive behavioral methods to be reserved to clear examples that demand that sort of treatment. Most experienced therapists also know the average client has problems that confound the clear use of cognitive behavioral methods and must resort to some emotional centered process to aid in the cognitive behavioral process. So while logic may be empirically validated, the actual practice requires the use of emotional settling processes to clear the way for these empirical methods.

\

CHAPTER 8

CRITICISMS AND CONCLUSIONS

These notions about nonlinearity and therapy are not without comment and controversy. For instance Gottman et al (2002) has suggested that researchers consider nonlinearity as if it were like qualitative research. The problem with this approach is that qualitative research is a creature of the researcher whereas nonlinearity is deterministic mathematics and not subject to the irregularities of individuals. Certainly working with nonlinear equations may be daunting from some researchers; however the capacity to understand the totality of responses to the normal questions of life under normal conditions (not experimental) more than rewards the difficulty of mastering ordinary differential equations. In the long run as more researchers develop competence in differential equations, the bar may be raised in terms of curriculum.

With respect to how nonlinear research is conducted, the process resembles the way physicists develop theoretical models or "thought experiments." The researcher brings together ideas of what variables are within the boundaries of the proposed model. These variables are behaviors present in the model and the outcomes from the model that can be written as a mathematical expression. For instance, depression might be mathematically expressed in an equation that includes physical and emotional components that all add up to a mini-function that when plotted on a two dimensional (Cartesian) scale as a line the moves downward or upward over time when influenced by other equations that represent individual physical and emotional behavior (some which are very linear in thought). For this example, the plot might look like the daily behavior of the Dow Jones stock index. This plot represents the effect of many streams of data (some linear and some not) that all combined in the moment to look very nonlinear even though the underlying inputs maybe linear. The essence of the plot is a mathematical equation which makes for predictability and thus understanding of how the components interact with each other. Once the understanding of how the components (behavior) interact with each other, then treatments (altering equations) can be designed to change the outcomes (different plot).

Of course, the mechanics of a physics style "thought experiment" is fraught with problems of its own. For instance how are models created and evaluated. Model construction may come from several sources. First a known model (i.e., basic equation) can be cloned. The model should appear to cover all the variables of interest as well as the structure of the situation that the investigator is interested in evaluating. Second, a model can be constructed by using selected variables. The proviso advantage of this type of model is that many other variables or known behavior need to be included so that the model is anchored in known reality. Third, a model combining a known model and selected variables can be constructed. Finally, a model could be constructed of variables completely unrelated to each other so long as variables composed of known behavior also are included to anchor the system in reality. It is obvious from the model building process that any variable can be paired with any other variable so long as these variables are paired with a variable of known behavior.

As for outcome identification, these models always force upon the variable combination some form of attractors. So for each set of initial conditions a specific set of outcomes or attractors is produced. For each equation and set of initial conditions these attractors are unvarying.

Finally, once model dynamics are understood, so also understood are the possible treatment processes, when the processes should be applied, and what the probability of outcome of each outcome.

Another criticism is nonlinearity unnecessarily complicates research. Simple cases are easier to research and do not require complex differential equation analysis. The problem with this approach is the relatively low power of results. Perfect results from experiments are rare and the combination of results and power yield results that apply only to a small fraction of the population. On the other hand there are no simple cases in the real world.

Another possible criticism is the paucity of models and the models relationship to behavior appears obtuse. The answer to the first comment is that the field is new and so models are in short supply. This is to be expected in a developing field of inquiry. The development of models is the grunt work of developing a new science. As for the lack of relationship of models to behavior, recall that nonlinearity is imbedded in the process. Thus direct linear relationships should be rare. As a matter of fact, the development of models should be a bit of a hit and miss affair. Because embedding within the nonlinear process hides any linear relationships.

At the practical level, nonlinear dynamic techniques represent a new mathematical process to evaluate complex behavioral and longitudinal behavioral process. These techniques represent advancement over the current process of statistical measurement and analysis and in some ways complement the current statistical regime. For example Gottman et al research in to family dynamics is confirmed by nonlinear analysis.

First, nonlinear models (equation) provide a complete understanding of the connection between all initial conditions and all outcomes. Second, nonlinear models provide a complete understanding of the dynamics between initial conditions and outcomes. Finally, because the dynamics between initial condition and outcomes is manipulable, the dynamics of process is completely understood. This is unlike the statistical approach which requires pure behavior measurement and any contamination of pure behavior is confounded by intervening variables. In real life, behavior is always filled with confounds.

What makes this new method so useful is that the models produced provide the ability to backtrack from outcomes through the processes to understand where and how the processes went wrong. Because of the ability to manipulate the model, the best process (highest probability) can be predetermined given the initial conditions and outcome objective. Clearly, the main advantage of the models is an understanding of how the whole integrated process operates over time and thus what clues to look for when processing with a client, for example.

These criticisms will abate as more empirical research like Kelso's is published and as more models become available for researchers to draw upon.

This paper has been an attempt to bridge the understanding between Gestalt therapy and nonlinear dynamics. Discussed were the principles of Gestalt therapy and the mathematics of nonlinear dynamics. Also discussed where the mathematics of nonlinear dynamics matched the principles of Gestalt therapy. A possible human equation for interaction behavior was considered. Possible problems with nonlinear dynamics such as an experimental verification of Gestalt therapy were presented.

REFERENCES

Abraham, F. D., Abraham, R. H. & Shaw, C. D. (1990). *A visual introduction to dynamical systems theory for psychology*. Santa Cruz, CA: Aerial Press.

Alexander, R. A., Herbert, G. R., DeShon, R. P., & Hanges, P. J. (1992). An examination of least-squares regression modeling of catastrophe theory. *Psychological Bulletin, 111,* 366-374.

Ash, M. G. (1995). *Gestalt Psychology in German Culture,1890-1967*. Cambridge, UK: Cambridge University Press.

Basar, E. (1990). Chaotic dynamics and resonance phenomena in brain function: Progress, perspectives, and thoughts. In E. Basar (Ed.), *Chaos in brain function* (pp. 1—27). New York: Springer-Verlag.

Barton, S. (1994). Chaos, self-organization, and psychology. *American Psychologist, 49,* 5-14.

Boker, S. M. (2001). Differential structural equation modeling of intra individual variability. In L. M. Collins & A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 5-27). Washington, DC: American Psychological Association.

Buber, M. (1958). I and thou. New York: Scribner.

Burley, T., & Freier, M.C. (2003). *Character: What it is and what to do about it*. In press.

Clair, S. (1998). A cusp catastrophe model for adolescent alcohol use: An empirical test. *Nonlinear Dynamics, Psychology, and Life Sciences, 2,* 217-241.

Combs, A., Winkler, M.,& Daley, C. (1994). A chaotic systems analysis of rhythms in feeling states. *Psychological Record, 44,* 359-368.

Darwin, Charles. (1871). Descent of man. New York: Penguin.

Ehlers, C. L. (1995). Chaos and nonlinear: Can it help us to understand mood and behavior? *Archives of General*

Psychiatry, 52, 960-964.

Elkaim, M. (1990). *If you love me, don't love me: Constructions of reality and change in family therapy.* New York: Basic Books.

Freeman, W. (1990). Searching for signal and noise in the chaos of brain waves. In S. Krasner A(Ed.), *The ubiquity of chaos* (pp. 47—55). Washington, DC: American Association for the Advancement of Science.

Freeman, W. (1991, February). The physiology of perception. *Scientific American, 264,* 78-85.

Freud, Sigmund. (1900). *Interpretation of dreams.* New York: Random.

Geert, P. van. (1998). A dynamic systems model of basic developmental mechanism: Piaget, Vygotsky, and beyond. *Psychological Review, 105,* 634-677.

Gleick, J. (1987). *Chaos: Making a new science.* New York: Viking Penguin.

Gottman, J. M. (1993). The roles of conflict engagement, escalation, and avoidance in marital interaction: A longitudinal view of five types of couples. *Journal of Consulting and Clinical Psychology, 61,* 6-15.

Gottman, J.M., Murray, J.D., Swanson, C.C., Tyson, R., & Swanson, K.R. (2002). *The mathematics of marriage: Dynamic nonlinear models.* Cambridge, MA: MIT Press.

Gottschalk, A. B., Bauer, S., & Whybrow, P. C. (1995). Evidence of chaotic mood variation in bipolar disorder. *Archives of General Psychiatry, 52,* 947-959.

Goudsmit, A. L. (Ed.) (1989). Self-organization in psychotherapy. New York: Springer-Verlag.

Greenberg, L. S., Rice, L. N., & Elliot, R. (1993). *Facilitating emotional change: the moment by moment process.* New York: Guilford.

Guastello, S. J. (1988). Catastrophe modeling of the accident process: Organizational subunit size.

Psychological Bulletin, 103, 246-255.

Guastello, S. J. (1992). Clash of the paradigms: A critique of an examination of the least squares regression technique for evaluating catastrophe theory hypotheses. *Psychological Bulletin, 111,* 375-379.

Guidano, V. F. (1991). *The self in process.* New York: Guilford Press.

Haken, H., Kelso, J. A. S., & Bunz, J. P. (1985). A theoretical model of phase transitions in human hand movements. *Biological Cybernetics, 51,* 347-356.

Hanges, P. J., Braverman, E. P. & Rentsch, J. R. (1990). *Changes in rater's impression of subordinates: A catastrophe model.* Manuscript submitted for publication.

Hanges, P. J. (1987). *A catastrophe model of control theory's decision mechanisms: The effects of goal difficulty, task difficulty, goal direction and task direction on goal commitment.* Unpublished doctoral dissertation, University of Akron, Akron, OH.

Hanson, S. J. & Olson, C. R. (1990). *Connectionist modeling and brain function: The developing interface.* Cambridge, MA: MIT Press.

Haynes, S. N., Blaine, D.,& Meyer, K. (1995). Dynamical models for psychological assessment: Phase space functions. *Psychological Assessment, 7,* 17-24.

Heisenberg, W. (1930). *The physical principles of the quantum theory.* Chicago: University of Chicago Press.

Hoyert, M. S. (1992). Order and chaos in fixed interval schedules of reinforcement. *Journal of the Experimental Analysis of Behavior, 57,* 339-363.

Hufford, M. R. (2001). Alcohol and suicidal behavior. *Clinical Psychology Review, 21,* 797-811.

Hufford, M. R.; Wikiewitz, K..; Shields, A. L., Kodya, S., & Caruso, J. C. (2003). Relaspe as a nonlinear dynamic system application to patients with alcohol use disorders. *Journal of Abnormal Psychology, 112,* 219-227.

James, William. (1890). *Principles of psychology*. New York: Cosimo.

Jantsch, E. (1980). *The self-organizing universe*. Elmsford, NY: Pergamon Press.

Kauffman, S. A. (1993). *The origins of order*. New York: Oxford University Press.

Kelso, J.A.S. & Tuller, B. (1984), A dynamical basis for action systems. In M. S. Gazzaniga (Ed.), *Handbook of Cognitive Neuroscience*. New York: Plenum Press.

Kelso, J. A. S., & Schoner, G. (1988). Self-organization of coordinative movement patterns, *Human Movement Science, 67,* 27-46.

Kelso, J. A. S. (1995). *Dynamic patterns: The self-organization of brain and behavior*. Cambridge, MA: MIT Press.

Koffka, K. (1935). *Principles of gestalt psychology*. NeYork: Harbinger.

Kohler, W. (1947). *Gestalt psychology*. New York: Liveright.

Kohler, K. (1969). *The task of gestalt psychology*. Princeton, N.J.: Princeton University Press.

Kohonen, T. (1988). *Self-organization and associative memory*. New York: Springer-Verlag.

Lewin, K. (1935). *A Dynamic Theory of Personality: Selected Papers of Kurt Lewin*. New York: McGraw-Hill.

Lewin, K. (1951). *Field theory in social science*. New York: Harper & Bros.

Levine, R. L. & Fitzgerald, H. E. (1992). *Analysis of dynamic psychological systems*. New York: Plenum Press.

Lorenz, E.N. (1963). Deterministic nonperiodic flow. *Journal of Atmospheric Science, 20,* 130.

Lorenz, Henrick. (1904). Electromagnetics in a system moving with velocity small than that of light. *Proceedingd of Academy of Sciences, Amesterdam, 1,* 427-442.

Marks-Tarlow, T. (1999). The self as a dynamical system. In *Nonlinear dynamics, psychology, and life sciences, 3,* 311-345.

Maxwell, James Clark. (1873). *An elementary treatse on electricity.* Oxford: Clarendon Press.

Morrison, F. (1991). *The art of modeling dynamic systems.* New York: Wiley.

Oliva, T. A., Peters, M. & Murphy, H. (1981). A preliminary test of cusp catastrophe model in the social sciences. *Behavioral Science, 26,* 153-162.

Orsucci F. F. (2002). *Changing Mind: Transitions in natural and artifical environments.* New Jersey: World Scientific.

Perls, F. S. (1947). *Ego, Hunger, and Aggression.* New YorK: Random.

Perls, F., Hefferline, R. F., & Goodman, P. (1951). *Gestalt therapy: Excitement and growth in the human personality.* New York: Jullian.

Polster, E & Polster, M. (1973). *Gestalt therapy integrated.* New York: Random.

Putnam, F. (1988). The switch process in multiple personality disorder and other state—change disorders. *Dissociation, 1,* 24-32.

Reidbord, S. P. & Redington, D. J. (1992). Psychophysiological processes during insight oriented therapy: Further investigations into nonlinear psychodynamics. *Journal of Nervous and Mental Disease, 180,* 649-657.

Roschke, J. & Aldenhoff, J. B. (1992). A nonlinear approach to brain function: *Deterministic chaos and sleep EEG. Sleep, 15,* 95-101.

Saari, D. G. (1977). A qualitative model of the dynamics of cognitive processes. *Journal of Mathematical Psychology, 15,* 145-168.

Sabelli, H. C. & Carlson-Sabelli, L. (1989). Biological priority and psychological supremacy: A new integrative paradigm derived from process theory. *American Journal of Psychiatry, 146,* 1541-1551.

Schuldberg, D. A. (1999). Chaos theory and creativity. *In* The encyclopedia of creativity *(Vol. 1)*. London: Academic Press.

Sheridan, J. E. & Abelson, M. A. (1983). Cusp catastrophe model of employee turnover. *Academy of Management Journal, 26,* 418-436.

Sheridan, J. E. (1985). A catastrophe model of employee withdrawal leading to low job performance, high absenteeism and job turnover during the first year of employment. Academy *of Management Journal, 28,* 88-109.

Skinner, H. A. (1989). Butterfly wings flapping: Do we need more "chaos" in understanding addictions? British Journal *of Addiction, 84,* 353-356.

Stewart, I. (1989). *Does god play with dice? The mathematics of chaos*. Cambridge, MA: Basil Blackwell.

Stewart, I. N.,& Peregoy, P. L. (1983). Catastrophe theory modeling in psychology. *Psychological Bulletin, 94,* 336-362.

Streeter, V.L. (1958). *Fluid Mechanics*. New York: McGraw-Hill.

Strogatz, S.H. (1994). *Nonlinear dynamics and chaos: With applications to physics, biology, chemistry, and engineering*. Cambridge, MA: Westview Press.

Ta'eed, L. K., Ta'eed, O. & Wright, J. E. (1988). Determinants involved in the perception of the necker cube: An application of catastrophe theory. *Behavioral Science, 33,* 97-115.

Thorndike, Edward. (1898). *Animal intelligence*. New York:

Cosimo.

Turvey, M. T. (1990). Coordination. *American Psychologist, 45,* 938-953.

Tuving, E. (1985). How many memory systems are there? *American Psychologist, 40,* 385-398.

Vallacher, R. R.,& Nowak, A. (1994). The stream of social judgment. In R. R. Vallacher & A. Nowak (Eds.), *Dynamical systems in social psychology* (pp. 251-277). San Diego, CA: Academic Press.

Vandervert, L. (1991). A measurable and testable brain-based emergent interactionism: An alternative to Sperry's mentalist emergent interactionism. *The Journal of Mind and Behavior, 12,* 201-220.

Waldrop, M. (1992). *Nonlinear: The emerging science at the edge of order and chaos.* New York: Simon & Schuster.

Wertheimer, M. (1924, December). Gestalt theory. An address before the Kant Society, Berlin. In W. D. Ellis (Ed. & Trans.), *Source book of gestalt psychology.* New York: Harcourt, Brace and Company.

Zeeman, E. C. (1976). Catastrophe theory. *Scientific American, 23,* 65-83.

UNIVERSITY LIBRARIES
LOMA LINDA, CALIFORNIA