A CRITIQUE OF SELECTED DEVELOPMENTAL PARADIGMS USING TRANSFORMATIONAL THEORY

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INTRODUCTION

Rationale for the Study

There is continual evidence that society has a fascination with defining human development by measures of certainty. Spodek (1988) remarks that "there is no universal agreement about what constitutes human development" (p. 204), yet state departments of education and local districts institute mandates and policies that are founded on inconclusive, and even contradictory, viewpoints of human development. Issues of grade placement and retention particularly spawn controversy and confusion among members of the field and the general public as well.

The epistemological base of developmental theory, for the most part, has been established through scientific activity. Capra (1982) notes that the Newtonian-Descartes vision of absolute certainty and determinism "is still widespread today" despite the fact that: "Twentieth-century physics has shown us very forcefully that there is no absolute truth in science, that all our concepts and theories are limited and approximate" (p. 57). Nonetheless, society's cultural mindset of Western thought, according to Clark (1988), has been to maintain the Newtonian-Descartes "technological world view" that the universe functions with clockwork cause-effect precision. Translated into the context of human development, this means that a child can be expected to develop and behave according to the patterns and predictions that have been laid out by developmental theorists who uphold the laws of the Newtonian-Descartes paradigm, or old science.

Using old science, theorists reduce the human to his/her smallest component parts to arrive at an understanding of the whole being. In this way old science puts forth a building-blocks rationale for defining the human's development. Clark (1988) asserts that the "empirical logic" of old science "discounts intuition and value-based perceptions and forces us into an 'either/or' problem solving and decision making mode" (p. 18). As a result, developmental strategies are "fragmenting, linear and sequential."

In affirmation, Lucas (1985) acknowledges that the Newtonian paradigm is unquestionably the dominant thought of the day. Even though "abandonment of Newtonian mechanics as a paradigm for understanding reality is relatively well advanced" (p. 165), society is not ready to relinquish its hold on this causal-predictive mode of defining reality. But new scientific discoveries have been made, Lucas adds, which disclaim this Newtonian "metaphysical view of the world" (p. 165).

According to Lucas, the earliest challenge to old science came "at the beginning of the twentieth century" with revolutionary discoveries by Einstein, Heisenberg, and Bohr (among others) who founded the theories of relativity, uncertainty, and complementarity as they formed the genesis of quantum mechanics. Schopen (1989) notes that, taken together, these discoveries refute the "mechanical model" of old science "with the recognition that the physical world could not be separated into independently existing elements or isolated entities." Schopen elaborates with the following:

> These, once regarded as physical (e.g., so-called particles of atomic physics), on closer inspection scarcely seemed to retain the essential characteristics of matter at all. Instead, these supposedly fundamental building-blocks dissolved into wave-like probability patterns (p. 12).

By the same token, it can be seen that new science (instituted by quantum mechanics) would abandon the deterministic building-blocks method of defining human development for an alternate approach that contributes to understanding. As of yet, however, a direct application of new science to human development has not been made. One of the purposes of this study is to bridge that gap.

CHAOS: New Science's Emergent Paradigm

In Chaos: Making A New Science, Gleick (1987) promulgates the emergence of a new paradigm, the science of

Chaos. Throughout the book Gleick describes how the paradigm's emergence follows Kuhn's (1970) explanation of the paradigm process.

Kuhn (1970) asserts that the scientific community has as its goal the practice of normal science, a rule-bound mode of investigation that seeks to validate theory. But according to Kuhn, "normal science repeatedly goes astray" (p. 6). This happens because the normative principles are invaded from time to time by anomalies (irregularities) which deviate from the rule and challenge the rational explanation.

The paradigm concept was introduced by Kuhn as the metaphysic that guides the aims and activities (research) of the scientific community. Rather than being a logical, restrictive statement of beliefs about a phenomenon, a paradigm presents a sketch, or portrait, of a field's pattern (framework) of thought. A paradigm thus "stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community" (p. 173).

According to Kuhn, there is a process by which a paradigm emerges in a field. During a pre-paradigm era, a scientist will attempt to suppress the anomalies which arise in a study. This is because the researcher of normal science has a stake in the outcome. The purpose of the study is, in fact, to validate that which is already known. This occurs during the era of normal science.

When, however, anomalies appear to the degree that they can no longer be ignored by the scientific community, a paradigm emerges into what is described as a scientific revolution. At this point research deals "more with the qualitative than with the quantitative aspects of nature's regularity" (p. 30). Manipulations of theory need no longer to be undertaken by the scientist.

In sum, when a paradigm can no longer stand up to the weight of the anomalies, the scientific community goes through a period of crisis. At such a time, divergent theories are created to resolve the state of unrest within the field, most of which die out due to inherent anomalies of their own. Eventually, a particular body of beliefs emerges which seems to better end the "interschool debate" and the "constant reiteration of fundamentals" (p. 18). Thus, as scientists are able to transform a set of extraordinary investigations into a "shift of professional commitments" (p. 6), a new paradigm is born.

Actual domination of a new paradigm may not occur rapidly because older scientists tend to be reluctant to reject the studies of their lifetime for a new professional belief. For this reason numerous paradigms are able to exist simultaneously within a scientific community, even though a particular paradigm can better resolve the crisis of the field. Kuhn (1970) submits:

> To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it can be confronted (pp. 17-18).

The scientific community is, therefore, subjected to an era of unrest as the proponents of the competing paradigms seek to advance their respective interests. Ultimately, however, a triumphant paradigm prevails to establish the dominant thought of the field. Once the paradigm becomes accepted by the professional community, normal science resumes.

According to Gleick (1987) the Chaos paradigm has not triumphed as the dominant paradigm; however, the new science--combining the revolution of quantum mechanics with even more recent discoveries--is emerging with increased momentum. And in contrast to the Newtonian paradigm of determinism, these discoveries hold that the universe is comprised of randomness, nonlinearity, irreversibility, and uncertainty. Therefore, the phenomena of nature are unpredictable.

As Gleick describes the emergence of the Chaos paradigm, he notes that even the processes which bring a paradigm to the fore encompass the assumptions of randomness, nonlinearity, irreversibility, and uncertainty. And in turn, these same assumptions encompass the processes of transformation.

The science of Chaos promulgates transformational theory. In a nutshell, chaos represents the randomness of fluctuations which perturb a system, or organism. Many perturbations go unnoticed by the system, but on those occasions when the system chooses to respond, its entities (component parts) become stirred up, or chaotic. A physicist will measure the entropy, or messiness, of a system to approximate the degree to which the system is perturbed (Pagels, 1982). The response to an initial fluctuation may trigger the system into subsequent bifurcations, or jumps, into differentiated states of increased entropy, or messiness. Thus as the system continues to bifurcate, it becomes increasingly complex. Prigogine and Stengers (1984) note, however, that in the quantum leaps that lead a system to transform, the system finds "order out of chaos" (p. 292).

Nonlinearity enters into the process by the fact that transformations do not occur as a result of a sequential, building-blocks pattern. The bifurcation paths are encountered both randomly and in a nonlinear fashion. Because it cannot be known when, or how, a system might choose to respond to a fluctuation--or whether it even will respond--the theory incorporates the assumption of uncertainty. Finally, in accordance with the principle of entropy, all changes (bifurcations and transformations) are one-directional. Prigogine and Stengers (1984) thus associate the law of entropy (the second law of thermodynamics) with the "arrow of time" (p. 8). The law of entropy states that all changes are irreversible; once perturbed, a system can never return to its former state.

In the following section it will be shown how these assumptions of Chaos (transformational theory) enter into the process by which a paradigm comes to be recognized. Gleick's (1987) pronouncement of the Chaos paradigm's emergence illustrates how the assumptions can be universally applied.

The Paradigm Process

According to Gleick, the Chaos paradigm began to form as a few rebel scientists from across the fields attended to the anomalies that were being ignored by the majority of scientists who were practicing normal science (i.e., the Newtonian-classical, old science). These rebels comprised only a random sprinkling of scientists from across the globe who perturbed the macro-system.

Because the rebels attended to the anomalies, or irregularities that are ignored by those who practice normal science, the studies of these rebels could not be approached in a building-blocks manner. Their research could not incrementally add on to what was already known. Thus the Chaos scientists chose nonlinear paths to develop their scientific knowledge.

Once discoveries were made, the rebel scientists became irreversibly changed. Kuhn (1970) notes that the road to a paradigm shift leads the field(s), and the scientists therein, to a state of transformation. For this reason Kuhn states: "The conversion experience that I have likened to a gestalt switch remains, therefore, at the heart of the revolutionary process" (p. 204). Once these scientists became converted to the revolutionary insights that were gleaned from their respective discoveries, the transformations that they experienced became irreversible. These scientists would never be able to return to their former ways of thinking! Kuhn further acknowledges the irreversibility of transformation with the following:

> What were ducks in the scientist's world before the revolution are rabbits afterwards. The man who first saw the exterior of the box from above later sees its interior from below. Transformations like these . . . (are) almost always irreversible . . . (p. 11).

Finally, the road to paradigm emergence still left the scientists with a sense of uncertainty. Gleick discussed how these individuals originally came upon their discoveries in isolated points across the globe. As these scientists from an array of different fields came upon each other's work through such means as papers/publications, conference presentations, and by word-of-mouth, they came to recognize a widespread commonality of their multi-field discoveries. But these scientists also encountered points of disagreement and argumentation. It came to be seen that while the rebel scientists could agree on the general assumptions of randomness, nonlinearity, irreversibility, and uncertainty, they would remain at odds on some particulars. Because absolute consensus could never be reached, the Chaos scientists validated the assumption of uncertainty.

The assumption of uncertainty has led proponents of transformational theory to the recognition that much of the universe is paradoxical. While the assumptions lead to a global, or holistic, frame of thought, the particulars remain debatable. These paradoxes allude to the fact that unknowns may have to remain as such. This study will present two such paradoxes: 1) between Feigenbaum and Prigogine and Stengers who argue over the universality of bifurcations, and 2) between the humanistic psychologists who tend to agree, and yet disagree, over the nature of human transformation.

Having discussed old science and introduced the new (i.e., the science of Chaos and transformational theory), the rationale will look at human development from the lens of educational practice. It should be noted that, by and large, educational practice is approached from old science's Newtonian-mechanistic rationale. Because the issue of placement and retention tends to be the area of concern in the context of human development as it relates to schooling, the researcher has chosen to explore educational practice in light of the promotion/retention, or placement, question.

Developmental Placement: Promotion or Retention

Bjorklund (1986) undertook a study of the research on student placement and retention to see if research has supported the contention that repeating a grade benefits the child's learning and development. In the study, she found as much support for retaining children as she found for passing them on. Bjorklund adds, however, that most of the research favors children not being enrolled in kindergarten until they have reached the age of five. Pain's (1981) study counters this claim noting that in Edmonton, Alberta little difference was found in the child's school success when the entrance age was increased.

Pennsylvania's (1985) handbook on promotion/retention policies notes that even though findings on the benefits of retaining a child are inconclusive, the 423 districts of the state are being required to tighten their "district promotion and retention policies and standards" (p. 7). The writers of the handbook state:

> There is no reliable body of evidence to indicate that grade retention is more beneficial than grade promotion for students with serious academic difficulties (p. 8).

Yet the issuance of mandates on promotion/retention standards leads to decisions being applied to masses of children who match up to the established criteria without considering the children as unique human beings.

Other states which have also required the establishment of such policies include Connecticut (1984) and Oregon (1985). These offer alternate kinds of programs (e.g., transitional pre-first grades) which tend to be translated into spending two years in a first grade.

Cross' (1984) study of a local district's promotion/retention policy found teachers tending to ignore standardized test scores, and other criteria, to base their retention recommendations solely on the child's reading performance. Cross finds this to be a weak basis for making such determinations. The standardized test scores revealed that children who were retained scored comparably in reading with others passed on to the next grade. It appears that a child's oral reading can be used to determine his/her school placement.

In contrast to the district of Cross' study, Austin (1983) relies heavily on standardized tests for making placement determinations. Using the Iowa Test of Basic Skills (ITPA), the child's performance on measurable skills is compared against the normed performance standards. Here it is the test that is used to determine whether the child will be allowed to promote.

Schuyler's (1983) follow-up study on Austin's promotion/retention plan suggests that in the year after retention, the formerly retained students tend to remain below the average. Schuyler urges, therefore, that student needs be considered beyond the year of retention.

The above illustrations of state/district policies reveal two conditions of our educational society: 1) that human development is an issue of concern, particularly where grade placement or retention is concerned, and 2) that after all the centuries of grade-level structured mass education, the value of retention is <u>still</u> debatable. Though most of the above apples to primary/elementary situations, the problem is no less critical for students in secondary education.

Holloway (1985) discusses an unnamed district's proposed policy on the retention of students in grades 7-12 who make D's or F's on their report cards. In fact, any grade below C- would require that the "course be repeated until a passing grade and credit was earned" (p. 3). The goal is to cause students to become more serious about their academic efforts.

Holloway's conclusions propose that many unintended outcomes would result from the adoption of this proposed plan. For one thing, the district's adherence to the bell curve philosophy would continually perpetuate the condition of some students remaining on the lower end of the curve. These students would never have a chance to complete high school. Organizationally, the model would prove to be deficient as students continued to repeat courses, thus creating an over-load of class size where the number of incoming students would become disproportional to those graduating.

Of most importance, however, is the fact that many students would perceive this as a "no win" affair. These students: ". . . could be expected to respond in the only legitimate way they can and that would be to 'withdraw'" (p. 13). Not only would the students be greatly discouraged, Holloway cautions that "their behavior might become even less manageable than is presently the case" (p. 13).

This alert to the bad behavior of young people trying to cope with failure leads the issue of development back to a societal problem. As emphasized by Clark (1988), society tends to handle such problems by resorting to methods of normal science. It is traditionally proposed--since the time of Newton and Descartes--that the phenomenon be reduced to something that can be isolated, observed and measured. Only then can a cure be found.

Many states and districts have now gone to a format of "high-stakes testing" to determine the readiness of children to begin schooling. Meisels (1988) describes Georgia's 1986 legislation, the Quality Basic Education (QBE) Act, as the greatest "abrogation of instructional authority" ever imposed upon children in testing. Meisels explains the bill with the following:

> This bill required all children seeking to enter first and fourth grades to pass a test that would demonstrate their academic readiness. Students who did not pass such tests and, in kindergarten, whose teachers confirmed the results of the readiness assessment, would be required to repeat kindergarten or third grade (p. 37).

This test used to demonstrate this academic readiness is the California Achievement Test (CAT), a standardized instrument which utilizes normal science methods to measure all the complexities of the human which are deemed pertinent to school success. Here the potential for school success is defined by demonstrated (paper and pencil) mastery of language and mathematics skills. Meisels adds that the CAT is designed to:

> . . . render decisions about student classification, retention, and promotion; it is intended to guide instructional decisions; and it is perceived as carrying out the state's mandate to establish quality education programs. Unfortunately, the test and the testing program fall far short of achieving these goals (p. 37).

In a report by O'Neil (1988), of the 90,000 kindergartners tested in Georgia under the new law, "more than 7,000" were not able to "attain passing scores" (p. 1). O'Neil notes that many are protesting the Georgia plan for setting a ". . . bad precedent and (being) symptomatic of a nationwide over-emphasis on academic skills in kindergarten programs" (p. 3). But Weiss (1988) in the NEA Today asserts that:

> Kindergarten testing is, of course, only the beginning of students' long careers as test takers. The National Center for Fair & Open Testing (FairTest) estimates that at the very least, public schools administered over 100 million standardized tests last year. That's an average of more than two-and-a-half tests per year (p. 5).

The article suggests that it is a misuse of tests to determine placement, retention, or tracking by a single test score.

A number of districts employ developmental tests to determine placement decisions. Though also standardized, tests such as the Gesell School Readiness test propose an activity (or paper and pencil drawing) orientation to determining one's level of development. Still Meisels (1988) asserts: "The problems with the Gesell are extensive . . ." (p. 34). The primary fault of the Gesell, according to Meisels, is that:

> . . . it promises to identify children who are at high-risk for school failure, and it asserts that it can be used to determine when children should begin school, which children should be promoted, and which should be retained in grade. Unfortunately, there are no data to support these assertions (p. 34).

In sum, even a test designed specifically for developmental purposes is suspect to invalidity.

It appears that the methods of normal science have not been successful at describing and alleviating problems which tend to be identified as developmental; specifically, grade placement and retention. Criticisms of the standardized paper and pencil measures (e.g., CAT testing), and those which are deemed developmental (e.g., the Gesell test) indicate that the normal science approach of reducing data for prediction has been ineffective and, possibly, harmful.

The Developmental Paradigm

Many policies and practices that are implemented in American schools are derived from the theories of developmentalists Arnold Gesell, Jean Piaget, and Maria Montessori. Gesell's work is most notable through the developmental tests which are used to determine children's readiness for starting school (Ames, 1967). Montessori is most known for the preschools that have been established nationwide to advance children's academic readiness for school (Goodlad, Klein, & Novotney, 1973). It has been the works of biologist Jean Piaget, however, which have increasingly met with acceptance by the members of the educational community.

Since the late 1970s Piaget has been revered as the leading developmental theorist (Brennan, 1982). The literature is inundated with Piaget's writings, and the works of his proponents who continue to carry on with their creations of a Piagetian curriculum. The National Association for the Education of Young Children (NAYEC) manual for "developmentally appropriate practice" (Bredekamp, 1987) is written in accordance with Piaget's theory.

In sum, the developmentalists have gained recognition in the literature, and support for the establishment of: 1) tests that indicate a child's development level, 2) schools (i.e., the Montessori preschools) for enhancing academic readiness, and 3) instructional programs (e.g., the Piagetian and Montessori curricula). Furthermore, state and local policy makers have drawn from the theories of these developmentalists to formulate promotion/retention policies. (It should be noted that Piaget did not address matters of education, but his constituents have developed programs that extend Piaget's theory into practice. The active learning model that the Piagetian and Montessori curricula espouse are considered in the formulation of, for example, transitional pre-first grades that are used as options in the promotion/retention handbooks developed by state departments.)

The Humanistic Paradigm

Humanistic psychology attempted to combat the deterministic rationale of the Newtonian paradigm in the 1960s and 70s. Humanism was only moderately received by the psychologists and educators of that time; consequently, the humanistic paradigm never attained a status of dominance in the social sciences. Nonetheless, Schopen (1989) holds that the humanistic movement laid the foundation for the "wholistic world view" espoused today. According to Schopen: "Humanistic psychologists such as Carl Rogers and Abraham Maslow, and their stress on seeing the person as a whole being, shaped our world view, then and now" (p. 13).

The "wholistic world view" to which Schopen refers is the underpinning philosophy of those who propose transformational theory. Both Ferguson (1980) and Leonard (1972), author of The Transformation, advocate the need for viewing the person in a holistic context as opposed to dissecting aspects of the human for measurement or analysis. Leonard criticizes the educational community for reducing children to their "reading and mathematics achievement scores" (p. 235). And Ferguson adds that: "Where they need to find meaning, the schools ask memorization; discipline is divorced from intuition, pattern from parts" (p. 284). Clearly the call is for transformation! Finally, in the context of human development, Ferguson (1980) proposes:

> Mind, in fact, is its own transformative vehicle, inherently prepared to shift into new dimensions if only we let it. Conflict, contradiction, mixed feelings, all the elusive material that usually swirls around the edges of awareness, can be reordered at higher and higher levels. Each new integration makes the next easier (p. 69).

As a holistic thinker, Ferguson alludes to the messiness of life, and the bifurcation (shifting) processes, that encompass transformation.

In accordance with Schopen's assertion that the humanistic psychologists (i.e., Rogers, Maslow) tend to be in congruence with the "wholistic world view," Lucas (1985) notes that Maslow views the human: ". . . as an active, dynamic initiator of action, selecting and responding to certain features in the surrounding phenomenological 'field'" (p. 169). This active responding to the fluctuations of life in a dynamic manner also seems compatible with transformational theory.

But whether the humanistic paradigm is, in fact, congruent with transformational theory, as suggested by Schopen and Lucas, is a matter that will be explored in the study. One of the main goals for this research is to arrive at an understanding of the assumptions that underlie both the developmental and humanistic paradigms.

Purpose of the Study

This study is an attempt to explore new science to see if it offers an alternate paradigm that can be used to critique selected developmental theories. If so, the researcher will seek to demonstrate in this dissertation how the emergent paradigm of Chaos--transformational theory--can be used to critique the dominant paradigm of development as guided by old science, and an alternate paradigm that espouses development according to the humanistic psychologists. Because this is a theoretical study, no hypothesis is proposed. The purpose is to come to understand.

Basic Assumptions

In this study, the basic assumptions are:

1. Human development approximates the development of new science in accordance with the premise that change in the organism is the result of anomalies, or fluctuations, which perturb, and ultimately, transform the human, or the field(s).
2. Viewed as a dissipative (open, biological) structure, the constituents of human development are randomness, nonlinearity, irreversibility and uncertainty (or unpredictability).
3. The linear and sequential nature of stage theories postulate development as a process of rational and logical order which directly opposes the assumptions of the new paradigm of Chaos.
4. Perceptual orientations to development, as propounded by humanistic psychologists, offer philosophic congruence to the assumptions of Chaos and transformational theory.
5. Human development can only be understood with the recognition that no description can adequately define the present, or predict the future, of the human in the universe.

Organization of the Study

The study is presented according to the following chapters. A brief description is provided for each.

Chapter 2:

The developmental paradigm is rooted in old science. Each of its founding leaders was a scientist in his/her own right: Piaget, a biologist, and Gesell and Montessori, medical doctors.

For these individuals a biographical perspective is provided so that the reader can understand how their respective theories of development happened to evolve from a scientific orientation. Clearly for these developmentalists the human nature has an order which can be predicted and rationally explained.

Chapter 3:

In Chapter 3 the reader will be introduced to the new science of Chaos and transformational theory. A survey of scientists from the fields of chemistry, physics and mathematics, astronomy, and biology will enable the reader to see why the emergence of the Chaos paradigm is beginning to gain attention. Additionally, reference will be made to scientists of the past who subtly, in their respective fields, paved the way for this revolution suddenly to emerge to the forefront in the 1970s and 80s.

Chapter 4:

The fourth chapter will present a brief description of the humanistic paradigm's roots, followed by a discussion of its opposition to the Newtonian deterministic rationale of normal (old) science. From here Chapter 4 will propose a new science that accords with the assumptions of Chaos; the humanistic paradigm will propose the acceptance of transformational theory as a viable way of understanding the developing and transforming human being.

Chapter 5:

The final chapter of the study will present a synthesis relating transformational theory to the general philosophies of development as postulated by the leading developmental and humanistic theorists. In response to recent issues over the child's placement in school, Chapter 5 considers such decision-making only in light of the findings gleaned from new science. Therefore, questions related to developmental issues of schooling (grade placement/retention) are viewed from the lens of the emergent paradigm of Chaos, or transformational theory.

Limitations of the Study

The findings of this research can only be applied with recognition of the study's limitations. Although the introduction addresses problems associated with the developing child in regard to grade placement and retention, concrete solutions to these issues are not sought in this study.

The human inherently possesses a multitude of unknown complexities, and because the human is a dynamic being, forever open and in flux with things in the world, it is not feasible, according to transformational theory, to offer generalizable predictions. The study will, hopefully, enhance the reader's understanding of the limitations that impede a scientist's ability to prescribe solutions to problems that bear upon the uncertainties of the developing--transforming--human being.

Another limitation of the study exists in regard to the researcher's interpretation of the reviewed literature as prior knowledge was integrated with the new information. Every effort was made to understand and discuss the literature in accord with the theorists' intentions. Nonetheless, the possibility of bias, though unintentional on the part of the author, is a limitation that must be acknowledged.

Additionally, the study was also met with the limitation that the science of Chaos--transformational theory--is a relatively new area that touches all of science's fields. Yet this newness carries with it the limitation that books and publications are scarce; and for some fields, difficult to come by. Specifically, the literature on transformational theory is limited.

CHAPTER II

THE DEVELOPMENTAL PARADIGM

Developmental psychology is rooted in many of the natural sciences. Munn (1965) describes the field as "the most complex phenomenon known to science" because it deals with the "behavior of living organisms" (p. 9).

According to Munn, it is from physics and chemistry that developmental psychology knows of organic functions (e.g., nervous and glandular activity, cellular differentiation). Branches of zoology contribute with related information. The "protozoologist" provides the developmentalist a glimpse into the structure and functions of even the smallest living organism. Through genetics, the developmental psychologist is able to consider factors of inheritance and evolution which bear upon development. The naturalist then brings to light the animal's sense of adaptation, life in its habitat. Finally, the embryologist opens up, for understanding, the infant's early stages of life.

Munn further notes that the social sciences (i.e., sociology and anthropology) are also "closely affiliated" with developmental psychology because the human being is studied from the era of savagery to the age of modern civilization.

In this way the developmentalist comes to consider the cultural milieu from which personality develops.

The developmental paradigm has combined the above into two broad areas of focus: phylogenetic and ontogenetic problems. Phylogenesis focuses on the nature of the organism's "unlearned and intelligent behavior . . . ranging from the unicellular organisms to man" (p. 11). Here the developmentalist is most concerned with the evolution and heredity of the organism, including its "mode of transmission, and adaptive significance of unlearned relations" (p. 10). Ontogenesis, then, studies the "nature and bases of behavioral development from conception until birth; the subsequent development of sensory, motor, symbolic, and emotional processes" (p. 11), on to the development of the personality. In essence, the phylogenetic activities are those which all humans have in common (e.g., grasping, crawling, running, speaking). The ontogenetic activities, on the other hand, comprise those aspects of the human (habits) which one may, or may not, acquire (e.g., swimming, skating).

Munn suggests that historically, phylogenetic psychology originated with the work of Charles Darwin in the latter nineteenth century. Darwin's studies probed into the possibility that the human's behavioral traits could have prehuman origins. Developmentalists who supported Darwin's theory began to consider human development in relation to the behavior of animals. Among others, Munn lists Thorndike's 1898 investigations of "animal learning at Columbia

University" (p. 3) as an early phylogenetic study of development. But Munn notes that subsequent behavioral studies of the rat led American behavioralists "away from . . . comparative and phylogenetic research" (pp. 3-4). Thus phylogenetic research is not equivalent to studies which investigate "neural and physiological mechanisms" (p. 4).

Ontogenetic psychology shares with phylogenesis the concern for biological implications in development. The ontogenetic psychologist agrees with the doctrine of recapitulation, that the "structural characteristics of animals lower in the scale of evolution are exhibited in the prenatal development of the human infant" (pp. 4-5). As a result, the individual "mirrors" the "biological history" of his/her race. However, ontogenetic psychology submits that development encompasses more than just a passing down of the race's "structural characters" (p. 5). Environmental and cultural influences also affect development.

Munn further notes that this ontogenetic theory of development was initiated in the late 1800s by G. Stanley Hall who combined recapitulation (phylogenesis) with a concern for causal, environmental factors. In so doing, Hall created a theory of "cultural recapitulation," or ontogenetic psychology.

Through ontogenesis, psychology is able, for example, to understand why children "manifest different types of play as they grow older" (p. 5). A pure phylogenetic perspective would limit play to the types of activities that a dog might exhibit (e.g., fetching the ball), which do not tend to change (heighten in complexity) as the dog increases in age. Ontogenesis allows for such growth.

It is important to note that a developmental psychologist will not be purely phylogenetic, neither will his/her orientation be so directed to the environmental/cultural side of ontogenesis that the phylogenetic implications are ignored. A developmental psychologist must encompass both perspectives in his/her theory. Otherwise, the theoretician is perhaps a behavioralist, or a humanist, but not a developmentalist (Munn, 1965). On the other hand, the developmentalist may tend to lean more to a phylogenetic or ontogenetic orientation. It is important, therefore, to be knowledgeable of these distinctions upon studying the proponents of the developmental paradigm.

Arnold Gesell, Jean Piaget, and Maria Montessori are three developmental theorists whose work has impacted educational practices in the United States. Across the nation efforts are made to actualize the ideals of these developmentalists in public and private school settings, early childhood philosophies, and state and local policies; particularly, these developmentalists are looked to where policies on grade placement and retention are concerned. After discusing the application of these developmentalists' theories in preschool settings, Goodlad, Klein and Novotney (1973) state:

> Although forward-looking and well-conceived, then, the California report, like so many others, does

> not quite come to grips with the vital question of what early education and schooling are for. The more the report gets into specifics, the more we see the seemingly inescapable academically oriented activities of an early school preparing for a later school instead of activities designed with the goal of each child's discovering and expanding himself as a person (p. 155).

The point is not that these theorists espouse the use of preschools to ready the child for subsequent grade placements, but that the educational community tends to use the theories of Gesell, Piaget, and Montessori with such purposes in mind. It is for this reason that a study of these theorists' beliefs should be undertaken. An investigation of what each of these individuals espouse, as opposed to how their theories are used, is warranted.

Arnold Gesell, Jean Piaget, and Maria Montessori were each a scientist in his/her own right, and each has made a substantial contribution to developmental thought. For this reason, the three theorists are presented individually in hopes that the reader will become acquainted with both the scientific and the developmental implications of their respective theories.

Gesell: A Developmental Leader

Arnold Gesell's acclaim as being a founding leader of child development research in the United States is reaffirmed by Crain (1985). After receiving his Ph.D. in psychology, Gesell embarked upon his career so painstakingly that, at the age of thirty, he returned to graduate school to receive a medical degree.

According to Crain, Gesell is known for having ". . . developed one of the first tests of infant intelligence . . . and was one of the first researchers to make extensive use of film observations" (p. 15). Before the publication of Spock's famous books in the early forties which dealt with the care of infants, Gesell was heralded as the nation's leading baby doctor. In fact, Crain notes that even Dr. Spock was influenced by Gesell's work.

A Man of Science

In his autobiography, Gesell (1968) notes that he studied at Clark University under the "genius" G. Stanley Hall "whose outlook embraced the total phylum, and lifted psychology above the sterilities of excessive analysis and pedantry" (p. 127). Gesell refers to Hall as "a naturalist Darwin of the mind" whose psychology influenced the direction that his own studies would take.

Upon receiving his doctorate in medicine Gesell was awarded a full professorship in the graduate school of Yale. He concurrently accepted a position as a psychologist for the Connecticut State Board of Education to study actively the handicapped children in schools. During these years Gesell's interest in clinical child psychology heightened. Public attention came to Gesell when a publication on the preschool child met with wide acceptance. Gesell followed this with other such books. Recognition for these efforts brought Gesell a series of grants which set his child studies research into motion.

Gesell sought to analyze the morphology of development, how the organism functions as a whole. His research was an attempt to study the functions--the morphology--of organismic development. Gesell blended his backgrounds of medicine and psychology to arrive at an understanding of how the organism, the child, evolves from birth to adulthood. From his affiliation with G. Stanley Hall, Gesell incorporated a strong phylogenetic perspective in his research undertakings.

Philosophy of Science

As a progeny of Hall, and a proponent of Darwin, Gesell describes his scientific viewpoint as a theory of recapitulation (Gesell and Gesell, 1912). Holding that human development cannot be understood without going back to the beginning of life, the Gesell's assert that "animals, in their individual unfoldment . . . recapitulate the phases of their phyletic or racial development" (p. 20).

The Gesells track the evolution of man from the primordial sea with its complex substance (protoplasm) of molecules, through their changing forms (which resemble the amoeba of today), to the evolution of lizards, and then other animals. According to the Gesells, the process of evolution involves a multiplication of cells, along with a differentiation in cell structure and function. Differing forms of a higher order occur as a result of "variation and mutation, through natural selection and through other means only poorly known" (p. 33).

The Gesells further explain how humans have evolved from lower animal life. The differing human parts, particularly the muscle system, are likely to have originated in some type of worm. Similarly, the human shoulders and thighs appear to be derivatives of the fish species. The arboreal mammals furnished the beginnings of human arms and legs. Finally, Gesell and his wife propose that in ancient times, the central portions of the human body were all that existed. More recent periods of history, however, brought about the peripheral features (i.e., the arms and legs). The Gesells hold that the nervous system evolved on an "installment plan, from fundamental to accessory" (p. 42).

In sum, Gesell's philosophy of science implies that development encompasses a sequential building on of cells, tissues, organs, body parts--capacities. Nature appears to organize itself for the purpose of attaining a higher level of intelligence. An implicit notion of linearity regarding how living things evolve to a higher order is conveyed in Gesell's theorizing.

Developmental Theory

According to Gesell (1945), morphology as a study is concerned with the form and structure of an organism as a whole. Embryology is the study of genesis (beginnings) and form. Gesell's goal is to combine these perspectives to study the life cycle.

By starting with the point of conception and following the organism on through its stages of development the schedule or "patterning process" of the life cycle can be understood. According to Gesell, the genes lay down the ground plan which provides them the "capacity to propagate themselves and to reorganize surrounding molecules" (p. 93). From this embryological state, the fetal scale of development emerges to set the life cycle in motion.

Gesell and Ilg (1946) propose that the life cycle can be characterized by stages which denote the changes that occur from time to time in the human's development. To describe these changes, the authors have identified "growth gradients" which embrace "some seventeen age levels, and ten major fields of behavior" (p. 2). Herein growth is defined as: ". . . a concrete process which produces patterns of behavior" (p. 4). The growth gradients thus depict the child's maturation as his/her behavioral patterns change in character.

The authors add that the "maturity traits" are meant to represent typical behaviors which tend to occur at particular age listings. In this way, an observer should be able to derive some inclination of the child's behavior in relation to his/her expected maturity level. The charts are intended to impart to parents and educators the trends that are common in a child's development. Therefore Gesell and

Ilg propose: "We should be mainly concerned with the position of a child in a forward moving cycle" (p. 5).

The Development of Cognition

According to Gesell and Ilg (1946), the child cannot be defined by the distinct parts of his/her structure. The child is, after all: ". . . bound up with his nervous system, and indeed with his entire organism" (p. 19). Therefore, the mind should not be viewed as a separate entity.

It is the nervous system which makes the child a singular unit. The mind grows and develops as part of that vast network of sensory, motor and associative neurons. The authors suggest that: "The mind grows because the tissue grows" (p. 19), and the neurons also are empowered to grow. In fact, the neurons multiply at an unfathomable rate in even the embryonic and fetal periods "when the foundations of behavior are laid." A five-month old fetus may have twelve billion or more nerve cells which will continue to multiply throughout his/her cycles of development.

Intelligence, then, is a function of growth. Gesell and Ilg contend that the mind functionally consists of "propensities and patterns of behavior" (p. 20) which are only apparent through the child's external behavior patterns. Moreover, the patterns of thought are "lawfully related to each other" in such a way that an analogy can be drawn between the vast networks of the mind and a cloth richly woven in threads. However, the organic fabric--the mind--has the capacity to grow, and it creates new patterns as it grows. On the matter of learning, Gesell and Ilg suggest:

> Parents and teachers who think that a child is so plastic that he can be made over by strenuous outside pressure, have failed to grasp the true nature of the mind. The mind may be likened to a plant, but not to clay. For clay does not grow. Clay is moulded entirely from without.. A plant is primarily moulded from within through the forces of growth (p. 20).

The growth gradients can be used by parents and teachers so that the unfolding of a child's development might be ascertained.

Because Gesell and Ilg adhere to the phylogenetic view of development, it is their contention that one's development of cognition is innately predetermined. As a consequence, the characteristics listed on the growth gradients are based on the assumption that cognitive development is an inherent aspect of the child's nature.

One then might ask: If the child's actions stem from his/her innate nature, how is that behavior affected by the culture? Gesell and Ilg contend that the child's nature is maintained in his/her acculturation as the child participates through a process of "self-projectiveness" which enables the child to incidentally suggest his/her own uniqueness while assimilating the culture.

The authors suggest that acculturation is the universal task of the school. The teacher's task is to "induct" the child into society's heritage through schooling. However, the induction cannot be socially transmitted; rather, it "must be lived into" (p. 375) by the child. The real task, then, is for the educator to consider the psychological and growth needs which arise in the child's progression through the growth gradients. The curriculum can, according to these authors, facilitate healthy development for the child by being footed on the assumption that the "mechanisms of development . . . do not change; and the child remains true to his own unique patterns of growth and of adaptation" (p. 23).

Implications for Schooling

The colleagues and followers of Gesell at the Gesell Institute of Child Development, particularly Frances L. Ilg and Louise Bates Ames, believe that school success has more to do with the child's readiness to grasp the teaching than with the standards per se. Ames, Gillespie, and Streff (1972) contend that the school cannot bear the total responsibility for the child's failure or success because "the answer more often than not lies in the organism, not in the environment" (p. 82). However, it is acknowledged by these authors that the school does have its influence over the child. For this reason Ames et al. suggest that the child be protected from harmful influences through careful consideration of his/her grade placement. Ilg, Ames, and Baker (1981) explicate the Gesellian philosophy even further:

> It is the Gesell Institute position that at least half of the school failures now experienced in the early grades could be prevented or cured if children started school only when they were fully

> ready. We recommend starting all children in school, and subsequently promoting them, on the basis of their behavior age rather than their birthday (chronological) age or their level of intelligence (p. 237).

The rationale which supports this position is presented below.

<u>Physical Structure</u>. The build of the child's body has much to do with the way he/she interacts with the world. Ilg et al. (1981) propose that even when children "grow up in the same environment" (p. 3), the differences in the structural builds affects each child's personality. A child may have deep-seated feelings about his/her physical appearance for this is the "raw material out of which personality is formed" (p. 49).

An aspect related to one's physical structure is one's size. In school the size of a child may be a positive or negative factor, depending upon how the child's size compares to his/her classmates. Ames (1967) asserts that not all children of a particular physiological age (size) match the level that is associated by the same chronological age. Because physical size is not a dependable measure of the child's maturational age, "a careful behavior examination to see just where he is behaving" (p. 43) is in order.

<u>Diagnosis</u>. It is the policy at the Gesell Institute to diagnose every child so that a determination of his/her readiness to enter school can be made. Ames (1967) contends: "Such an examination would indicate whether or not

he is ready for the work of the grade to which his legal age assigns him" (p. 11). Two specific reasons are explicated for the evaluation in Ames et al. (1972): "(1) it is easily accomplished; (2) when it comes at the beginning of the school career it can, if made in time, prevent the school failure that might occur without it" (p. 13). It is added by the authors that intelligence testing, the I.Q. quotient, be included in the evaluation although it does not serve as the primary criterion for basing a placement determination. Ames et al. propose that when "planning for any child's school experience, one of the most useful measures we have is that child's intelligence quotient" (p. 207).

Ilg et al. (1981) express that the intelligence aspect should not influence the diagnostician to prescribe cures. The biological reality is such that careful attention to specific factors may cause the educator to ignore "the rest of the web" (p. 333). Nonetheless, these authors propose that "individual behaviors develop predictably" (p. vii).

If that is the case, then the Gesell diagnosticians, at least implicitly, predict the child's future performance because empirical data are obtained for determining appropriate grade placement. These prescriptions are based upon the criteria for maturation described in Gesell's growth gradients, or stages.

<u>The Gesellian Stages</u>. Ilg et al. state that the stages of development are like steps. They note that children develop in remarkably similar ways. The steps are "pretty

much the same for everybody" and, to "get to the top, the child has to climb all the steps" (p. 4).

It is explained by the authors that development proceeds in a line which spirals in an upward formation. The child shifts, as he/she matures, from alternate stages of equilibrium to disequilibrium. Though the stages of disequilibrium cause the child to be somewhat difficult to live with (as his/her personality reveals signs of frustration and rebellion), these phases must be met in order for the child to grow. The following diagram of the stages is depicted by the authors (p. 8):

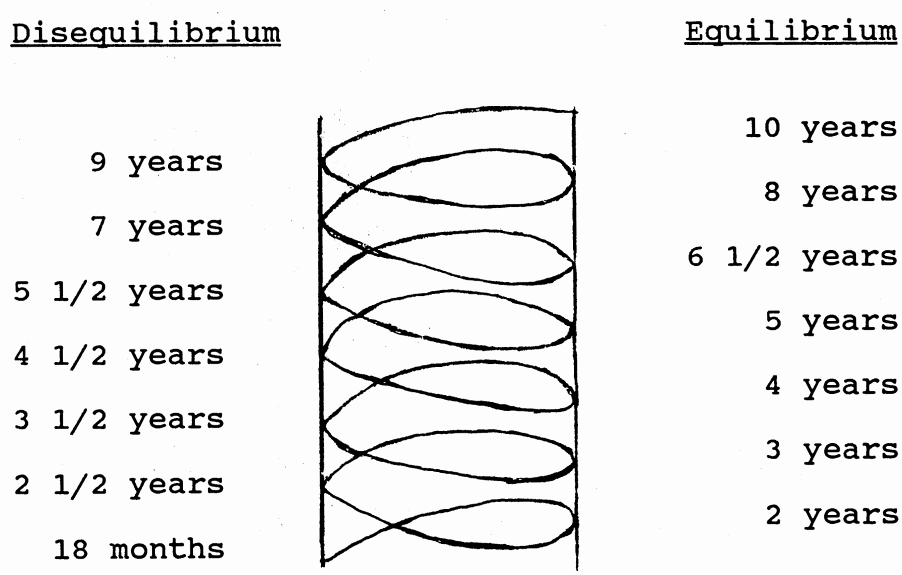

Figure 1. Gesellian Stages

Ilg et al. suggest that the parent and the educator attend to "the order in which these stages follow each other," for they hold that this line of order is "far more important than exact age at which any certain child reaches any one of these stages" (p. 15). Moreover, to prevent further setbacks in the child's development the authors propose that the parent and educator: "Know what to expect from your child at each stage of development and match your expectations to his or her skills" (p. 330).

Grade Placement or Retention. In her book, Is Your Child in the WRONG Grade?, Ames (1967) reports findings from the Gesell Institute which support holding back, retaining, the immature child. She proposes that a "tremendous amount of overplacement" occurs in the schools of today. Furthermore, "nearly all of the children brought to us because of school problems were overplaced . . . placed in a grade above that which their maturity level suited them for" (p. 5).

Ames asserts that age alone is not a sufficient criterion for predicting a child's performance at school. Moreover, repeating a grade can offer the unsuccessful child hope for a brighter school future. In fact, Ames' research suggests that for those children who were retained, "almost without exception" their school performance was "conspicuously improved." She adds that retaining the child "is no magic formula which will cure everything" (p. 30), but if the child's intelligence is not lacking, retention

"<u>can</u> lighten the load" (p. 31). Specifically, if the child's poor performance is due to a lack of maturity, or readiness, "repeating will in most cases work wonders" (p. 31).

Social promotion, on the other hand, is strongly opposed by Ames. She views social promotion to be an unwarranted decision which is used in the schools to keep from hurting children's feelings. The Gesell Institute finds this to be a senseless and even harmful practice. Ames expresses: "social promotion is like staying away from the doctor and pretending you are not ill in a case of serious illness. . . . If unready for promotion, a child needs to be kept back" (p. 124).

In support of this position, Ames et al. (1972) acknowledge that some psychologists propose that grade retention is psychologically damaging to the child; that the emotional damage of the retention would do the child more harm than the educational opportunity would afford him/her in repeating the grade. The authors argue that "new research evidence . . . put repeating in favor in an increasing number of schools" (p. 69). The research of the Gesell Institute finds that "nearly every child who is in serious trouble in school is overplaced" (p. 33), and for the child, living in such a threatening and frustrating environment is far more harmful than experiencing a degree of embarrassment over being held back. Any negative feelings that might initially be present are soon displaced by the relief that an appropriate placement promises.

Finally, even the Gesell Institute researchers of the 1980s uphold the position that favors grade placement and retention. Ilg et al. (1981) again recall the older psychological perspective which cautions educators about the harmful effects of grade repetition. The authors maintain however, that "such fears are largely groundless." They add that, assuming immaturity is the problem, in "nearly every instance . . . repeating does bring success" (p. 240).

It can be surmised that the Gesellian program supports having a child wait until he/she is developmentally ready to step into the academic arena that society establishes as schooling. Should the child emerge on to that scene before his/her innate capabilities have evolved (matured), then repeating the grade is the prescribed solution.

Patterns and Predictions. The current researchers at the Gesell Institute of Child Development contend that development occurs in the human in clearly predictable ways. As a result, "early tests are predictive" (Ames et al., 1972, p. 185). These authors assert that: ". . . our own research shows great stability in test scores from the very earliest ages on."

Among other things, the Gesell findings support the contention that girls mature faster than boys. Therefore, Ames (1967) submits "that it's an unusual boy who is ready for first grade before he is fully six" (p. 10). However, an explanation for the phenomenon cannot be found. Science has not discovered whether the cause is physical or cultural. Nonetheless, by virtue of the grade classification scheme, a young boy is expected to be able to compete with his female counterpart in school performance.

Ames et al. (1972) add that the ratio of boys to girls seen at the Gesell Institute for problems related to immaturity is 5:1 in favor of the boys. The authors blame this dilemma on the school for setting an arbitrary entrance age which has no regard for the developmental-gender differences. The significant point is, however, that this problem is predictable, and it can be greatly remedied by raising the entrance age for boys by one year.

Aside from the pattern of boys lagging behind girls in their early development, Ilg et al. (1981) note the existence of other peculiarities which can be predicted. There are, in the progressive line of "'improvement' in behavior" (p. 6), fluctuations which interrupt the steady flow of development with setbacks. As a result, development "does not go forward consistently." In describing the advantages and disadvantages of each level, the authors submit:

> Fortunately, all of these changes do not occur simply at random. Rather, they take place in a lawful and patterned way (p. 7).

It appears that the better and worse behaviors unfold in alternate stages "in a fairly lawful sequence."

A fluctuation to the difficult types of behavior indicates that a child has reached a stage of disequilibrium.

While the better behaviors which can be found in the stages of equilibrium are preferable to parents and teachers alike, the authors encourage the adults to have patience for "the child seems to grow through these opposite extremes. One kind of behavior appears to be as necessary to growth as the other" (p. 9).

The importance of these fluctuations in understanding Gesell's developmental theory can be found in the following statements: 1) a fluctuation is vital to one's growth, and 2) the fluctuations occur in a "lawful sequence." Therefore, it is these two assumptions which predicate Gesell's developmental theory.

Development is the progression of behaviors which occur in an ordered pattern of stages. As the child moves upwardly through the stages, his/her growth requires that he/she alternately shift from equilibrium to disequilibrium in a sequential, nonvariant way. According to Ilg et al., (1981), this process is not only patterned, but it is also highly predictable. Thus the Gesellian position on development as an ordered phenomenon of nature is articulated. Ilg et al. assert:

> Clearly our basic thesis remains the same. We continue to affirm that behavior is a function of structure. People behave as they do to a large extent because of the way their bodies are built. And behavior to a large extent develops in a patterned, predictable way. Not only do individual behaviors develop predictably, but the ages themselves have their own patterned, predictable characteristics (p. vii).

Conclusion

Gesell and his colleagues suggest that because development is primarily phylogenetic, the educator's role is to allow the child's inherent tendencies to unfold. Because society's grade level constraints interfere with the natural order of development, the Gesellian theorists propose that the child be placed in a setting that is non-antagonistic to his/her developmental level. Grade placements and retentions are deemed to offer viable solutions to the unnatural conditions which are imposed upon children by the organizational structure of schooling.

A further note of importance rests in the fact that because development is primarily phylogenetic, it proceeds in essentially the same manner for all, even though rates of development might differ. For this reason, growth can be predicted. Similarly, the same curricula; that is, programs, teaching, materials, and the like, should be applicable for all who share in these natural stages of development.

However, not all developmentalists lean so strongly toward phylogenesis. Swiss psychologist Jean Piaget offers a somewhat different perspective on the nature of human development.

Piaget: A Developmental Leader

Jean Piaget is often lauded as the authority on cognitive psychology. Phillips (1975) attributes Piaget and his associates as having accumulated, since 1927, the largest body of "factual and theoretical observations extant today" (p. 3). Greenspan (1979) declares that: "Piaget's cognitive developmental psychology has given us our most complete model for understanding the unfolding of human intellect" (p. 1). And Brennan (1982) concurs, noting that Piaget's influence has rivaled even the reputation of Freud "in terms of individual contributions to psychology during this century" (p. 326).

Cognitive psychology is described by Phillips as being a field concerned with structure over content, "with how the mind works rather than with what it does" (p. 6). Since the brain's functions can never be known in a confirmed or true sense, cognitive psychology seeks to infer the central processes which are organized by the brain. According to Zwingmann (1976), the human is distinguishable from the animal as a higher form of life because of the capacity for abstract reasoning which is available to the human being. The human can use "complex symbolic processes" to communicate knowledge. Therefore Zwingmann declares: "What is called 'humanity' and progress is to a large degree a measure of his consciousness and the development of his creative potentials" (p. vii).

Piaget has sought to understand how it is that the human is able to think abstractly. Brennan states that Piaget's studies have "shaped the direction of developmental research," making him the "dominant figure in this field"

(p. 326). But prior to attaining such approbation in the field, Piaget was first, and foremost, a man of science.

A Man of Science

In his autobiography, Piaget (1968) attributes his critical mind of scientific thinking to the influence of his father who "taught (young Piaget) the value of systematic work, even in small matters" (p. 237). In contrast, Piaget's mother had a "neurotic temperament" (p. 238) which created for all in the family a troubled home life.

To escape the pain that his mother's imaginings brought on the rest of the family, Piaget "started to forego playing for serious work very early." Additionally, he sought to emulate his father's critical mind and quest for truth. For Piaget, science opened up new possibilities.

Upon seeing an albino sparrow in the park, ten-year-old Piaget wrote a "one-page article" which he then sent to Paul Godet, director of the nearby museum. Godet invited the lad to spend two hours a week at the museum learning about "land-and-soft-water shells." This led to a four-year tutorage in which Godet taught Piaget to classify hundreds of mollusks. By the time Godet died (at the end of their fourth year together), Piaget had come to know:

> . . . enough about this field to begin publishing without help (specialists in this branch are rare) a series of articles on the mollusks of Switzerland, of Savoy, of Brittany and even of Colombia (pp. 238-239).

Amazingly, foreign colleagues of the field wanted to meet this expert on mollusks who had been publishing in the major journals, not knowing that the scientist was only a schoolboy in his early teens. Concerning the attention that he received at the time, Piaget confesses that the writings were "far from being accomplished feats" (p. 239). He acknowledges that it was not until 1929 that his writings on the mollusks offered legitimate contributions to the field of biology.

In sum, Piaget's quest for scientific thinking developed from early roots. The young Piaget was found to be: 1) emulating his father's example of scientific reasoning, 2) seeking an alternative mode of behavior to his mother's irrationality, and 3) serving as an apprentice to Director Paul Godet at the Musée d'histoire naturelle. These conditions predisposed Piaget to become a man of science.

Though Piaget received a doctorate "with a thesis on the mollusks of Valais", his interests probed into the realm of psychology. Piaget sought to understand the relationships inherent in "the problem of the whole and the parts" (p. 243). Formulating a theoretical system related to the problem, Piaget integrated his knowledge of science into his beliefs about human development. In reference to this integration of zoology-biology with psychology, Piaget notes: "I never believed in a system without precise experimental control" (p. 243). Subsequent work at the Binet laboratory in Paris enabled Piaget to initiate this scientific inquiry concerning the nature and origin of the human intellect.

Philosophy of Science

Piaget (1977) asserts that the general forms of knowledge must be in agreement across the scientific fields if they are to be knowledge at all. Above all, knowledge is "constructed and acquired by a continuous and laborious effort" (p. 31). As knowledge is constructed, its approximations are passed down through the ages to be revised by subsequent scientists who also use "deductive construction" (p. 36). Specifically, Piaget asserts that a field is historically developed through a succession of stages. In each distinct stage a new body of knowledge is constructed by the scientists who elaborate on findings of the past. Just as a field of study is constructed through historic stages, a human is developed through stages which also involve active construction: The subject (human) reconstructs an object (the world) via cognitive processes (i.e., adaptation and organization).

Piaget (1981a) illustrates how the broad fields of mathematics evolved through a succession of stages. According to Piaget, the first period of mathematics is marked by the works of the ancient Egyptians and the Greeks. The early Egyptians had only empirical forms of mathematics to meet their surveying needs. Higher mathematics were unavailable to the Egyptians because they had no conscious awareness of how their computations were conceived.

At the same time, the Greeks also had no understanding of the underpinning concepts that founded their mathematics. Even when Euclid developed geometric figures which provided "ways of describing real figures," the early Greeks would not allow any mathematics which "touched algebra" into the field. This was because they viewed algebra as ". . . just some sort of recipe dealing with a subject's reasoning; it was not part of mathematics" (p. 227). Piaget suggests that this limited perspective caused the first era of mathematics, Euclidean geometry, to fall at the end of the Alexandrian Period. Creativity wore out because of "the absence of any cognizance or any conscious awareness of one's own activity in mathematics" (p. 227).

In the second period, the human became conscious of having an active role in mathematics, largely as a result of Descartes' introduction of algebra. Descartes had been able to outline the algebraic operations in such a way as to "make a general statement that brings together what is common in the two fields of algebra and geometry" (p. 227). Thus there was a kind of building on as Descartes drew from Euclid's discovery to construct a new and higher level of mathematics. Newton then generalized the operations "to infinity" through his taking the algebra even higher to calculus.

Piaget notes how the succession illustrates that the field of mathematics began from a physical knowledge of perceiving and doing, to an operational mode of progressed thought. At last mathematicians were becoming conscious of the conceptual processes. Piaget submits that "these were all examples of becoming consciously aware of the operations that are involved in doing mathematics" (p. 227), but the mathematicians of that period "were still not aware of the structures." The mathematicians viewed each operation as "a free product" of the will. Piaget adds: "They were not yet aware that operations were tied to one another in structured groups" (p. 227).

Pointing to the <u>third</u> and present era of mathematics, Piaget heralds the works of nineteenth century Galois whose mathematics introduced the field to group structures and lattices. Through the group structures mathematicians are now able to see the interrelatedness of the knowledge they construct. Piaget sees this as a major breakthrough in the development of mathematics.

The evolution of mathematics through the ages is analogous, according to Piaget, to how knowledge evolves in the human from a construction of knowledge about physical objects to abstractions which can be highly complex. The development of these processes for the human is described below.

According to Piaget (1981a), human development begins with a kind of physical knowledge in which the infant utilizes sensory-motor capacities to come to understand the world. Cognition gradually develops to the degree that complex processes of abstract reasoning become available. The first stage exhibits an infant being totally unaware of his/her own role in the constructive processes; the same holds true with the early mathematician. In the second stage, the child (and the mathematician) begins to conceive of his/her role, but only in relation to discovering that role in the operations. Concrete objects are necessary to make this awareness complete. Finally, the third stage enables the child--and the mathematician--to put the operations "together into structures" (p. 227) of abstract reasoning. At this level, both the child, and the mathematician, have reached the stage of formal operations.

Piaget concludes by proposing that each stage requires a reflection upon the knowledge that was discovered in the past. Without some kind of building on, new knowledge would be impossible. Therefore, Piaget (1981a) proposes that progress was made because the individuals used "reflexive abstraction--on the advances that had been made at the previous stage" (p. 228).

Through this analogy, Piaget applies his belief about the logic of scientific reasoning to his theory of human development. For either the development of a broad field of study, or the human, it is the growth of logic that Piaget emphasizes. The premise for this theory, the development of cognitive structures through stages, is presented as Piaget (1981a) promulgates:

> The development of intelligence is a continuous creation. Each stage in the development produces something radically new, totally different from what was there before. And the whole development is characterized by these appearances of totally new structures (p. 223).

In sum, Piaget suggests that there is a universal nature about the way things happen; that is, whether it be the growth of logic evolving over centuries for the construction of a field such as mathematics, or the growth of logic within an individual being, the process is the same. Because Piaget views nature in accordance with this principle of construction, he postulates with colleague Barbel Inhelder the rationale that guides their scientific pursuits. Piaget and Inhelder (1976) state:

> We maintain . . . that it is one of the duties of psychology to try and find the links between behavior and organic life in general and those between man's cognitive development and his important scientific creations (p. 35).

This section has focused on the scientific implications of Piaget's philosophy regarding the development of knowledge. In the following part Piaget's theory is discussed in the context of human development.

Developmental Theory

Piaget's developmental theory rests on the assumption that intelligence is neither innate, nor is it hereditary. To Piaget (1981a), inherited traits do not necessarily manifest themselves at birth. He notes that ". . . there is always a fixed time scale to maturational development." For example, puberty comes at a relatively confined period of time in the human's life. But "in the development of intellectual stages there are very great variations" (p. 224).

Piaget notes that great differences have been found in the studies his colleagues have conducted throughout the world among individuals' varying rates of development. These findings indicate that cultural and environmental circumstances have much to do with both the rate and the ultimate level of one's intellectual growth. Maturation and innate tendencies have little to do with the development of logic. Hence, for Piaget, human development is not a process of phylogenesis, or natural unfolding. Piaget (1981a), states that:

> . . . the structures are not preformed, for it is not just a matter of unfolding according to an internal clock. There really is a construction for each individual, for it is a matter of his creation of something new (p. 224).

Knowledge is thus acquired through action. It is a matter of individual construction. Furth (1981) notes that Piaget's concept of action "is not limited to external action," for it is also an "internal structure" that "leads to a structuring of the environment" (p. 291).

This developmental theory based on construction provides for the identification of one's development through stage classifications. In Piaget and Inhelder (1971), the authors insist that: 1) "the operations of intelligence" take the individual through "clearly defined stages" and 2) "the process is entirely autonomous" (p. 356).

Inherent in Piaget's stage theory are the properties of logic and linearity, both of which stem from his adherence to the scientific method. The aspect of logic is derived from Piaget's assumption of formality. As one logically employs inductive and deductive reasoning in the constructive processes, the development of formal operations can be realized. Linearity describes the sequential framework of the stages which, according to Piaget, must be met in an ordinal, nonvariant fashion.

The logical (formal) and linear (sequential) features of Piaget's (1981b) stage theory are presented below in a biological context. Here Piaget contends that: ". . . these structures have essentially a biological meaning, in the sense that the order of the stages is constant and sequential. Each stage is necessary for the following one" (p. 205). Piaget adds, however, that children vary in the ages at which they reach particular stages. Thus chronological age does not necessarily match one's developmental level. Furthermore, in some cultures the stages are accelerated whereas in others they are more or less systematically retarded. Development is thus not a maturation of the nervous system as Gesell would suggest, but a process of interacting with one's environment. Piaget reiterates: "The order, however, remains constant" (p. 205).

In sum, the ultimate level of development cannot be predetermined on an individual basis, but the manner by which one proceeds through the stages can. It can thus be surmised that Piaget offers a linear, ordered, and certain--predetermined--route to development, at least in the context of his stage theory.

The Theory of Equilibration. According to Furth (1981), the theory of equilibration is the most significant of all of Piaget's concepts. Borrowed from biology, the word implies a "deep functional continuity . . . between organic and rational life" (p. 253). It took Piaget fifty years in the refinement of his theory to complete this theory. According to Furth, Piaget's equilibration has a fundamental equivalence to Newton's theory of a self-regulated system. Thus Furth suggests:

> . . . the role of equilibration for the development of knowledge is comparable to the theory of mutual attraction of physical masses with which Newton established the movements of the planets as a self-regulated system and eliminated the need to look for external causes. Similarly, if Piaget's concept of equilibration is adequately designed, many puzzling questions about the 'causes' of development should simply fall by the wayside. In short, equilibration is described as the self-regulation of human knowing. It regulates the network of cognitive 'cycles' and keeps them in more or less permanent balance (equilibrium) (pp. 253-254).

In sum, the equilibration theory is an explanatory principle that governs Piaget's entire theory. It suggests that human development is as precise as the earth's rotation around the sun. Just as it can be predicted that the sun will rise and set each day, so can it be predicted that human will construct knowledge through processes of adaptation as they proceed through stages of development. For according to Furth, the theory of equilibration "regulates the networks of cognitive 'cycles'" and provides for a balance in the system through its intermittent occurrences of equilibrium.

Piaget (1981c) describes equilibration in terms of three factors: 1) the physical environment (which involves both physical and logical knowledge), 2) innateness (which includes one's hereditary program), and 3) social knowledge (which includes social transmission).

The physical environment is constructed through the adaptive processes of assimilation and accommodation. Adaptation is the combined processes of assimilating and accommodating for the structuring of cognitive schemes. (One uses the functions of adaptation when thinking about things.) Phillips notes that a scheme is a "kind of minisystem; it is that property of action which can be generalized to other contents" (p. 11). Organization, the other primary function, occurs when one thinks about his/her thoughts.

It is through the adaptive processes of assimilation and accommodation that one constructs knowledge from the physical environment. At the same time that one is assimilating, taking in new information, the person's schemes are being accommodated, or modified, to fit the special characteristics of that which is being assimilated. Piaget contends that assimilation involves integration. Until the age of about nine, a child's system of structuration does not allow him/her to fully utilize the complexity of assimilation, which is an active, not passive, act of construction.

Upon constructing knowledge of things or objects in the physical environment, Piaget proposes that information is not drawn from the objects themselves. Rather, knowledge is gleaned from the person's actions on the objects. This is logico-mathematical experience. It involves a coordination of the person's actions (operations) and his/her own thoughts about those actions.

In regard to Piaget's (1981c) second concern for the biological-hereditary aspect of the equilibration theory, he holds that innateness, or heredity, is not an important part of development "since it is variable and it cannot lead to the kind of necessity that we feel" (p. 216). It is self-regulation that enables us to develop. Both our conduct and our logical operational thinking are self-regulated. The entire system of regulation is fundamentally that of equilibration.

The third aspect of equilibration, the social factor, appears in language and education. However, both are subordinated to assimilating. Piaget (1981c) contends:

> There can be no effect of social or linguistic experience unless the child is ready to assimilate and integrate this experience into his own structures (p. 216).

On Social Development and Affect. The social aspect of a child's life is noted in Piaget (1928). Here Piaget introduces the child's use of transductive reasoning. When the child thinks transductively, his/her assimilations deform the objectivity of things perceived. This is because the child is ego-centric, and can only perceive the world from his/her own point of view. However, as the "antagonistic characters of assimilation and imitation" (which distort reality to the child's ego-centric view) are removed, the child can both assimilate and imitate as "mutually dependent processes" (p. 180).

The mutual dependencies of the child's cognitive processes are analogous with Piaget's earlier description of equilibrium as movement in flux. Reciprocity is the ability to perceive from both perspectives; the other person's and one's own point of view. The notions of circularity and reversibility are implied. Equilibrium occurs for the child when his reasoning can float reciprocally between the two points of view.

As the child leaves transductivity--reasoning from particular to particular and not seeing the universal--a reciprocity of relations can be developed. Piaget's concern is not with the relationship per se (e.g., the child's relation to a peer); rather, it is the child's intellectual capacity to think about his/her relation to others that is important to Piaget's theory.

The assumption is that once the child can overcome his/her transductive (ego-centric) reasoning in regard to others, and come to view them with the logic of reciprocity of relations, then the child can have access to relations that exist in equilibrium and harmony, as opposed to dis-equilibrium and disharmony. The focal point, then, is on the child's capacity to think about relations in a reciprocal, nonego-centric way.

As reciprocity develops, and assimilation and imitation become mutually dependent, social relations are enhanced. Furthermore, as social relations attain more reciprocity, transductivity diminishes and the capacity for logical thinking increases. Piaget (1928) proposes:

> Social life therefore helps to make our mental processes reversible, and in this way prepares the path for logical reasoning (p. 180).

Social development is critical to the growth of logic.

The road that leads to logical thought requires that the child overcome the obstacles of: 1) transductivity (being conscious of only one's own point of view), and 2) pseudo-deduction (the assumption that one's own conception of reality is true). To these important concerns, Piaget submits: "The essence of thought is the attempt to make reality itself reversible" (p. 189). Furthermore, Piaget contends that when the child becomes able to detach him/her self from his/her own beliefs and "enter into any foreign point of view" (p. 72), he/she will be cognizant of the meaning of hypothesis.

<u>The Bringuier Interview</u>. In an interview with Jean-Claude Bringuier (1980), Piaget was asked how he stood in regard to the affective level of development which certainly has a part in social relationships. Bringuier asked, "Now, your approach to the problem of human evolution and stages, is strictly from the point of view of intelligence, isn't it?"

Piaget responded, "Yes."

Then Bringuier asked, "You don't deal with the affective level at all?"

Piaget stated, "Only because I'm not interested in it. . . . Because I want facts."

Bringuier responded, "And you don't find facts at the level of affect?"

Piaget answered, "The problem doesn't interest me as a scientific inquiry because it isn't a problem of knowledge . . ." (p. 49).

To illustrate his position, Piaget went on to describe the differing affective natures of two boys regarding the learning of mathematics. One boy likes the arithmetic lessons so he forges on ahead. The other boy does not care for mathematics so he convinces himself that he does not understand and grows to develop an inferiority complex. Piaget noted:

> The first boy will learn more quickly, the second more slowly. But, for both, two and two are four. Affectivity doesn't modify the structure at all. If the problem at hand is the construction of structures, affectivity is essential as a

> motivation, of course, but it doesn't explain the structures (p. 50).

Bringuier replied, "It's strange that affectivity doesn't appear at the level of structures, regardless! An individual is a whole" (p. 50).

Piaget concluded this part of the discussion by explaining that his emphasis on development rests with the cognitive structuration of knowledge. Even feelings, to Piaget, are relative to cognition. In this way, Piaget's theory maintains a linear track; that is, development is not holistic or multi-faceted. Rather, it is singularly focused on the development of the intellect. Piaget closed the discussion with:

> . . . in the study of feelings, when you find structures, they are structures of knowledge. For example, in feelings of mutual affection there's an element of comprehension and an element of perception. That's all cognitive (p. 50).

As previously stated, social development is intricately woven into Piaget's global theory of equilibration. The equilibration theory describes all of the human's systems for: 1) constructing knowledge from one's perceptions of the physical world, 2) regulating the biological/hereditary functions, and 3) assimilating the social context, all of which is founded on the principle of self-regulation. From the interview with Bringuier it can be seen, therefore, that to Piaget, social development is more a function of logic than it is of feeling, or affect.

Language Versus Logic. In Piaget (1981a) it is noted that one's social development occurs through the use of language, and through one's education. In these ways the child encounters the experiences to outgrow transductivity and to develop reciprocity of relations, the ability to reason beyond one's own point of view. Piaget adds, however, that logic does not develop from language. Piaget (1981a) asserts: ". . . linguistic progress is not responsible for logical or operational progress. It is rather the other way around" (p. 217).

In other words, as one develops on to higher operational levels, the individual's language becomes more sophisticated. Thus logic precedes language; and as a consequence, language is enhanced by the growth of logical thinking.

Theory Summation. In sum, it is the development of logic which is central to Piaget's theory. The generalization of equilibration is an attempt to describe how the individual continually constructs knowledge (advances in the development of logic) through processes of self-regulation. These are the processes of adaptation and organization.

Piaget (1981c) refers to equilibration as the self-regulation which exists in all levels of cognition from the most minute perception to the highest form of problem-solving. It describes the means by which one can move from a pre-operational stage, through many occurrences of trial and error, to the concrete operational stage of development.

Human development is to scientist (biologist) Jean Piaget all that encompasses equilibration. It is, according to Furth, the "episodic adjustment" between the processes of assimilation and accommodation "of the same scheme to the constantly changing contents to which it is applied" (p. 256). For as the human assimilates, objects and events of the world assume an inward direction which define the person as a knower of the world. At the same time, the person's accommodation assumes an outward direction which defines for the person the object or event to be known.

Knowledge, then, becomes a "relational concept" which relates the person to the world he/she encounters, whether that world be physical or social. Specifically, knowledge is "an interaction between innate intelligence and a given environment" (p. 256). It is "a constructive interaction" (p. 256) which incorporates: 1) the physical environment, 2) innateness/heredity, and 3) the social context--equilibration!

Finally, the three factors of equilibration (cited above) enable the human to construct knowledge internally. Piaget refutes theories which suggest that knowledge rests within the objects and events that are external to the human and must be socially transmitted. Instead, Piaget suggests that knowledge evolves within the person the same way that the knowledge of a field of study (e.g., mathematics) is constructed and evolves down through the ages.

Piaget (1981a) describes the stages that have led mathematics from the works of the early Egyptians to the mathematics of today. He identifies the construction of the field in three primary stages: 1) the early Egyptians' surveying, along with the Greeks' unconscious mathematical operations and Euclid's geometry; 2) Descartes' algebra heightened by Newton's calculus; and finally, 3) Galois' group structures and lattices. It is then pointed out by Piaget that the individual constructs knowledge in the same way that scientists have for centuries: through inductive-deductive processes of logical reasoning; and from reflexive abstraction, thinking back on what has been done. According to Piaget, both the scientist and the child construct knowledge through the processes of equilibration.

Inherent in Piaget's theory is the linear progression of knowledge which occurs as one evolves through stages from a physical (perceptual) knowledge of the world, structured by imaginal schemas (Piaget, 1951), to the logical (operational) knowledge that is structured by action schemes (Piaget and Inhelder, 1969). In regard to imaginal schemas, it should be noted that children's games are often symbolic representations of both conscious and unconscious "tendencies and feelings" (Piaget, 1951). A child may play with only one of two dolls and pretend that the smaller doll has gone away, leaving the larger doll to stay with "Mommy." Unknown to the child, the game may represent the child's jealousy of a baby brother/sister. Piaget (1951) asserts that the "whole thought of the child" (p. 170) lies between unconscious and rational thought. For the young child there is no separation between the two.

Imaginal schemas turn into action schemes as the child progresses from the preoperational stage to that of concrete operations. Piaget and Inhelder (1969) define a scheme as "the structure or organization of actions as they are transferred or generalized by repetition in similar or analogous circumstances" (p. 4). As the child approaches the stage of concrete operations, he/she is directly relating to objects and classes of objects. Through trial and error the child "becomes capable of reasoning correctly about propositions he does not believe, or at least not yet. . ." (p. 132). With the development of action schemes, the child can now construct knowledge as he/she acts upon objects through "hypothetico-deductive" processes.

In sum, the imaginal schemas of the preoperational child (who constructs knowledge from his/her perceptions of the physical world), become action schemes for the concrete operational child (who applies "logico-mathematical" operations to arrive at rational deductions from the objects or events which require problem-solving). Linearity becomes an inherent aspect of the theory in regard to the means by which the child moves from one stage to the next. Piaget (1981b) describes this process as both sequential and invariant. The theory further implies linearity as it focuses on the construction of knowledge that is logical and rational to the neglect of other aspects of development (i.e., social and affective). Piaget affirms this contention in Bringuier (1980).

Finally, Piaget (1981a) strongly opposes the phylogenetic theory of development, noting that the relatively fixed time scale of maturation is far too limiting to account for the autonomous differences which encompass development. Rather than being a biological process of evolution (in the Darwinian sense), development is the construction of knowledge (Piaget and Inhelder, 1971).

Implications for Schooling

Devries (1978) notes the difficulty that educators face as they attempt to translate Piaget's theory into a Piagetian curriculum. Two reasons that problems are encountered are: 1) Piaget does not espouse a theory of teaching, and 2) his theory is dynamic in the sense that one aspect is meaningless without knowing how a particular aspect fits into the theory as a whole. Teachers are not always aware of the need for coming to know the broader implications of Piaget's theory and, as a result, their efforts at application are often contradictory. DeVries continues:

> Preoccupation with the stages has led to the preschool objective of moving children from the preoperational level to the stage of concrete operations (p. 76).

When Piaget's entire work is reduced to a stage theory, the focus turns to a mastery of "scientific knowledge."

A second difficulty is in educators trying to reduce Piaget's theory to its "structural aspects" (p. 76). Whereas the stages depict the organizational format of how development occurs, they offer no information as to how one progresses from stage to stage. Piaget's purpose for discussing the stages is: ". . . to show that knowledge, especially logic, is not innate, but develops itself little by little" (p. 76). It took Piaget's construction theory to describe the dynamic processes and the "continuity between stages" (p. 77).

DeVries proposes that Piaget's overriding theme of constructivism is what educators tend to miss. Constructivism describes how operations develop through logico-mathematical structures. Here educators tend to try to get preoperational children on to the concrete stage by making them "more logical on the tasks" used by Piaget in his research studies. DeVries asserts: ". . . this application reduces the theory to the content of the tasks" (p. 77). She adds that while the task content <u>can</u> be taught, there is no guarantee that the child's structure of thought can be changed, for the development of logic is an internal process which cannot be externally imposed.

Similarly, Kamii and DeClark (1985) propose that teachers who implement the Socratic method of dialogue to get children thinking about content may be successful at fueling the child's mind into wanting to know. However:

> People . . . are not the source of feedback for logico-mathematical knowledge. That source is

> wholly internal to the child. It is the internal coherence of _his_ system of thought that is the source of feedback in logico-mathematical knowledge (p. 31).

In other words, the only feedback that Piaget would support as being effective for learning is that which is internal to the child. As a result, trial and error practices are critical to cognitive growth.

Reflective abstraction facilitates the child's development of knowledge, but this again is internal. In reflective abstraction, a child will think back over the wholes and the parts of the concepts (relationships) which he/she has previously observed. (This need not happen on the same day. A time lapse is possible.) As the child reflects back on the situation, he/she coordinates his/her thoughts with the relationships and organizes them into hierarchies until he/she is "able to say with the force of logical necessity" (p. 32) what the resolution should be.

The authors add that it is possible to facilitate this process with an exchange of viewpoints so long as the attempt to transmit the information socially to the child is not made. The only viable route to knowledge is through internal construction; therefore, offering feedback to a child through the format of red-marking the incorrect answers on a paper is an effort in futility.

Because Kamii and DeClark see the futility in attempting to transmit knowledge socially to children, they argue for doing away with all traditional instruction in the first grade and building a curriculum around "two kinds of activities: situations in daily living (such as voting) and group games" (p. xi). Instead of reserving games for rainy days or rewards, these authors suggest that the entire year of first grade mathematics be devoted to the playing of games. These are to replace, not supplement, "lessons and worksheets."

An inherent aspect of Kamii and DeClark's proposal for the use of games is the support for social interaction among the children, and the children with teacher, in the learning. Again, the authors are not suggesting that knowledge can be socially transmitted, only that opportunities for dialogue encourage young learners to probe into possible solutions as they become confronted by verbal challenges.

In regard to social development per se, Furth (1970) reminds the reader that the emotional aspect of social living is hardly addressed by Piaget. However, the assumption is made that once the child's knowledge is enhanced, so are his/her emotions. The key to social development, then, is to "link operative thinking with contact in the social environment" (p. 132). The following guidelines are offered by Furth:

> First, we help him grow intellectually by giving him occasions to which his knowing structures can be applied. Second, we introduce the child into social realities as an active participant. We give him to understand that, like physical reality, social realities are not simply given, but result from and require the intelligent contribution of individual persons (p. 132).

Specifically, Furth urges teachers to take children on excursions outside of the school building and, when possible, bring the outside world into the school. This can be done in concrete ways by bringing in guests, for example, but it can also be done in conceptual ways by building units with the children that create imitative situations of real life. Such projects incorporate group activities. Similarly, Furth encourages the use of role play and drama.

Finally, Furth attends to the "'hidden' environment" and its implications for children's social development. Here Furth refers to the kinds of implicit messages which teachers convey to children and the values which are transparently transmitted. He adds that messages of love and warmth are not enough.

Furth (1970) holds that the social and emotional adjustment go hand-in-hand, but intellectual development is also required. Therefore:

> A school system whose goal is geared toward healthy intellectual growth cannot but be conducive to healthy emotional and social growth. For this reason alone, my professional advice on problems of educational adjustment or motivation would be first to check the objective program that is offered to the child (p. 137).

Furth's contention is thus that the key to psychological health is through the building of a sound objective program. Social and psychological difficulties seem to be at a minimum when children's intellectual needs are met. Furth adds that there is a "close organic connection between intelligence and social reality" (p. 187).

Kamii and DeVries (1980) note that an intellectually stimulating environment need not be boring. They assert that adults who believe "that school is made for work" (p. 26), are still operating from an egocentric frame of reference! These authors suggest that children do not distinguish work from play, and neither should school be a joyless place. Unfortunately, though, the child's intrinsic desire for play, which is work for the child, is destroyed in the typical school curriculum. Schools are, instead, "imposing lessons and exercises that do not mesh with the learner's way of thinking" (p. 27).

In Kamii and DeVries (1978), the authors propose that "Piaget's constructivism does not imply a cookbook curriculum that can be used to educate all children in the same way" (p. xi). It is, therefore, important that the teacher be sensitive to the uniqueness of each child. The children should be encouraged to ask questions and to engage in experimentation as they search for solutions. In this way, young children are encouraged to decenter and to think beyond their own points of view so that other perspectives can be considered.

In regard to the social interaction aspect of using games to teach the concepts, Kamii (1982) suggests the following: "Figure out how the child is thinking, and intervene according to what seems to be going on in his head" (p. 41). Here Kamii cautions the teacher to correct only the thought processes that the child seems to be using, not the incorrect answer.

The teacher can use the error to determine how the child must be thinking. Also the child's behavior provides an indicator as to whether the nature of his/her difficulty is intuitive, spatial, or logical. By intervening into the child's thinking process, the teacher may be able to avoid calling attention to the wrongness so as not to stifle the child's initiative; while at the same time, provide the child with insight regarding the problem. In accordance with Furth, social development in a Piagetian model is viewed as cooperative, nonthreatening interactions that lead one to cognitive growth. Here the social context is of a learning-interactive nature.

Conclusion

The Piagetian curriculum poses a paradox in which both flexibility and rigidity are implied. On the one hand, the Piagetian curriculum leaves room for student choice and active processes through both learning games and general play (e.g., role play, clay). Moreover, peer learning is encouraged so that the children might develop in autonomy as opposed to a dependence upon the teacher's judgment (Kamii, 1982; Kamii & DeVries, 1978).

But on the other hand, the games and activities of the Piagetian classroom are designed to lead the child toward the development of operational thought (Kamii, 1982; Furth, 1970). Rigidity enters into the picture as the Piagetian teacher makes available to the children activities that will facilitate the child's progression through the stages (DeVries, 1978). Little is said about the aspect for self-selection for the sole purpose of seeking out knowledge for the intrinsic desire to know. Self-selection thus rests within the parameters of that which will lead toward operational (stage) development.

As DeVries (1978) points out, no true Piagetian curriculum exists; therefore, the attempt to push children on to higher stages contradicts the crux of Piaget's theory. Activities are intended to facilitate the child's construction of knowledge, but this can only occur according to the child's internal processes of structuration. And it is possible for a child to mimic processes observed through social transmission and still not have constructed the knowledge internally (Kamii, 1982).

Nonetheless, an educator of the Piagetian model is mindful of the purpose of the curriculum, to foster the child's conservation of tasks. For this reason, the Piagetian activities focus on the carrying out of logical operations, all of which is to, implicitly, lead toward the goal of stage development. In Piaget and Inhelder (1971) the conditions for stage development are stipulated:

> There are three necessary conditions for a system of stages. The stages must follow one another in a constant order in all subjects; each one must have a characteristic overall structure (not just one dominant characteristic); and these structures must be integrated into one another according to the order of their formation (p. 356).

It is because stage development is sequential and ordered that the Piagetian tasks are also sequential and ordered in regard to task conservation and meeting the criteria for the growth of logic. And as it becomes determined by the educator which activities to select for the facilitation of the growth of logic, the Piagetian curriculum appears to paradoxical: freedom is encouraged through the active manner of learning, yet freedom has more of a physical reality in regard to freedom of movement and expression, than an affective reality. For intrinsic motivation and desire for learning is disregarded except as it conforms to the environment centered on the construction of knowledge through tasks based upon logic.

The systematic nature of the Piagetian curriculum coincides with Piaget's biological perspective of organismic systems and how organisms evolve through processes of construction (Piaget, 1976). According to Piaget, children progress from the preoperational stage to the stage of concrete operations when they can conserve tasks. He notes that conservation "is closely related to operative reversibility" (p. 54).

In this way, Piaget is relating the principle of reversibility to his theory of cognitive operations, noting that both organic and cognitive systems seek homeostasis, or equilibrium. Reversibility is fundamental to both systems. The open organismic system requires movement back and forth as it (internally and externally) interacts with the environment. By the same token, a child in the process of learning engages in a "general interplay of reflective abstractions and reconstructions converging with this evolution" (p. 54).

In other words, the child reflects on his/her prior actions upon things in the environment. In so doing, the child is able cognitively to reconstruct these interactions as he/she evolves into higher stages. Once the child can cognitively reverse the operations (conserve), operational thought is at hand.

It is important to note Piaget's emphasis on the environment for it is here that Piaget parts company with Gesell. Rather than to view development as being an absolute maturational process of unfolding (phylogenesis), Piaget sees the child's development within the context of the environment (ontogenesis). The focus of the curriculum, then, is on how the child constructs knowledge from that environment.

As Piaget was beginning to develop his theory along this line, Maria Montessori was revolutionizing Europe with a compatible view of development. A discussion of Montessori's scientific orientation and philosophy of development follows.

Montessori: A Development Leader

Maria Montessori is well known for her work with impoverished children in the early 1900s at San Lorenzo, Italy.

Hiring a young servant girl to assist with the 60+ children, Montessori initiated one of education's earliest known programs for individualized instruction.

The Casa dei Bambini was set up in a spare room in the children's housing project; barely furnished, and offering only "pieces of sensorial apparatus" to serve as the educational equipment. Lillard (1972) states that Montessori wanted "only to compare the reactions of normal children to her special equipment" (p. 3) which she had formerly devised for work with the severely mentally retarded of an institution. Having found that the handicapped were responsive to her teaching technique, Montessori had hopes of the equipment being even more useful for normal education.

The success of the children of Montessori's Casa dei Bambini was so phenomenal, according to Crain (1985), that "by 1913 she was one of the most famous women in the news" (p. 49). As Montessori's recognition flourished, she was brought to America to meet with such people as Thomas Edison, Mrs. Alexander Graham Bell, and President Woodrow Wilson's wife, Margaret. She was asked in 1912 to give a lecture at Carnegie Hall "to overflowing crowds" (Lillard, p. 8), and was so pleased with the American response that she returned to the States in 1915.

On this trip Montessori demonstrated her teaching at the San Francisco World's Fair. A number of Montessori schools subsequently emerged across the nation, the first being in the home of Alexander Graham Bell. The press and educational journals became flooded with Montessori's pedagogy. Montessori was undoubtedly the developmental leader of the day!

But the renowned Montessori fell from grace in the American eye almost as quickly as she ascended to her throne. A "torrent of criticism" by psychological and educational theorists of the day clearly evoked an alarming sense of distrust over Montessori's methods. Lillard notes that the criticism of William Kilpatrick, a "leading exponent of John Dewey's philosophy" (p. 9), were instrumental in the collapse of Montessori's work in America. Thus by 1913 only sporadic references were made to Montessori in the literature.

Because of her sudden downfall, Montessori never returned to the United States. Her work continued to flourish, however, in Europe and other parts of the world. But forty years later a new spark of interest in Montessori's work arose in the United States as a result of a young mother's finding out about Montessori's work while traveling in Europe.

As it turned out, five years after Montessori's death, her works were granted a revival, particularly because of the young mother who brought interest in Montessori back to America. Thus a new generation of Americans sought to actualize the ideals which Montessori espoused. At the time of Lillard's (1972) writing, over a thousand Montessori schools had sprung up nationwide with the number increasing annually. Americans were now not only receptive of the Montessorian ideas, but "actively seeking them" (p. 17).

A Woman of Science

Crain (1985) notes that Montessori became, at the age of twenty-six, the first female physician in Italy's history. In this pursuit, Montessori first demonstrated her preference for a scientific mode of inquiry. She used the scientific method of observation throughout the remainder of her life as she systematically studied the learning behavior of children at school, or preschool. (In Europe, Montessori schools extended throughout the grades.)

Montessori's son, Mario (Montessori, Jr., 1976), asserts that his mother sought to study, beyond the surface level of behavioral manifestations, the underlying meaning behind children's actions. Her goal was to integrate the findings "into a comprehensive and coherent vision of man that took into account the full complexity of his existence on earth" (p. 5). Mario adds that his mother's aim had been from the start to "contribute to a comprehensive science of man." Moreover, the science should not be representative of only one discipline of thought, for human beings should be studied "from whatever angles modern science permitted" with the integration providing a more accurate description of the human nature.

Mario further notes that the integration was not intended (by his mother) to be eclectic, for that would only "confuse the issues." Instead, the integration should provide a "tentative blueprint encompassing the different fundamental aspects of the human situation" (p. 5). In sum, Montessori sought a global model in which the differing branches of science could be included for uncovering a more comprehensive (versus restrictive) philosophy of human development.

Philosophy of Science

Like Gesell and Piaget, Montessori (1967) seeks knowledge of the human species through a biological lens. She notes that when one investigates a living being (whether human or not) through a study of its cell life (organic origin), then one has surpassed the realm of philosophy "which is far from being wholly theoretical" (p. 29) and entered into the natural sciences. According to Montessori, one need not delve into "abstract" philosophical thinking about the human when science can cast a new light on the child.

Montessori continues by stating that although Darwin presented the scientific community a theory of explanation regarding how the human has evolved over a vast amount of time, his theory "can no longer be entertained in its old linear form" (p. 55). Montessori contends that the progressive steps of evolution as described by Darwin offer an inadequate description of the developmental processes. The following rationale is thus presented by Montessori (1967):

> Today, the vision of evolution has broadened; it has become spread over a bi-dimensional field,

> wherein are included many functional relationships, near and distant, which link up the activities of different forms of life. Those links are not to be interpreted just as simple examples of mutual aid, but as being related to a universal end concerning the total world environment--to a kind of oneness of nature. From the order which results, all receive the elements necessary for their own existence (p. 55).

Montessori thereby proposes an alternate view of the evolutionary theory, suggesting that each agent of creation, as well as each living being on the earth, is charged with a particular task which is to complement the functions of nature as a whole. This perspective opposes the notion of survival of the fittest. Additionally, rather than to support the contention that the perpetuation of a species occurs through a linearity of building on, nature--organismic life on earth--is sustained as each agent of being (from cell to fully created being) interacts with the other elements of nature. Montessori asserts:

> Life is not present on earth merely to preserve its own existence, but to carry on a process vital to all creation, and therefore necessary for every thing that lives (p. 56).

According to Montessori, it is the quality of interaction among the elements of nature which prevents the acceptance of a linear explanation of development. Her philosophy thus leans toward an ecological perspective which she describes in terms of the cosmos. In discusing this cosmic perspective, Mario, her son, surmises: "The idea then is to give a dynamic global view of how human life on earth has evolved, eventually forming what Maria Montessori called the 'Supra Nature'" (Montessori Jr., p. 104).

Mario continues, however, with a description of his mother's philosophy which reveals that order is an inherent property of her theory. Mario explains that:

> The inner order of the personality must be constructed through experiences in a structured world. Thus the child must have a coherent picture, on the broadest scale possible, of the ambience in which he is growing. Chaos will never stimulate it to real participation (p. 103).

All of the above suggests that Montessori herself views Darwin's theory as a narrow and linear description of nature's evolution. She proposes that development is not linear because the organic elements that sustain life do not function in a progressive series of change. Nature interacts in accordance with "another force" to unite "the efforts of all, so that they work toward a common end" (Montessori, 1967, p. 57).

There exists, therefore, an order to Montessori's conception of the cosmos which prevents the occurrence of chaos. To Montessori, Darwin's theory is not incorrect; it simply is not broad enough to describe the ecological manner by which all the elements of nature interact to create harmony in the cosmos. Montessori (1967) reiterates the inadequacy of Darwin's theory in relation to the child with the following:

> . . . the linear concept of evolution, which tries to explain descent by adaptation, by heredity and by the impulse toward perfection, is no longer enough. . . . So, in the child, besides the vital impulse to create himself, and to become perfect, there must be yet another purpose, a duty to fulfill in harmony, something he has to do in the service of a united whole (p. 57).

Just as nature does not simply improve over time, neither does the child develop through mere processes of unfolding. Montessori asserts that "the child, at birth, bears within him constructive possibilities, which must unfold by activity in his environment" (p. 57). Construction is only possible through the child's active interactions with the environment.

Montessori's constructivism parallels Piaget's theory. Unlike Gesell's theory of development which, borrowing from Darwin, views development as a natural evolutionary unfolding of innate tendencies, Montessori and Piaget adhere to the belief that the environment has much to do with the evolutionary processes. Their ontological perspective of development finds both Montessori and Piaget in agreement on the point that development entails evolution to some degree. But it is the convergence of the child's innate nature with the environment that steers the child on to higher manifestations. Montessori (1949) thus expresses the philosophy of science that, in turn, substantiates her theory of development:

> This is the vision of reality of our time: we the last earthbound men, must make the great effort of lifting up our eyes and hearts to understand it. We are undergoing a crisis, torn between an old world that is coming to an end and a new world that has already begun and already given proof of all the constructive elements it has to offer (p. 25).

It is being suggested by Montessori that the old world of progressive evolution must die so that a new vision of constructivism can be given birth in the biological epochs of science. This was Montessori's wish for the fifties; by the seventies, Piaget's theory of development through construction began to dominate the field of cognitive psychology. Piaget thus inadvertently led Montessori's philosophy of science to become an American realization.

Developmental Theory

Montessori (1967) proposes that one's development is related not to his/her "embryonic past," but to the individual's construction of knowledge as it relates to his/her interactions with the environment. Using the analogy of constructing buildings with stones and bricks, Montessori suggests that the reasons buildings differ "both in shape and in ornamentation" is not because of the "materials from which they are made but the different purposes they are designed to serve" (p. 49). It is the purposeful interaction with the stones and bricks which allows the building to be constructed in the particular way by the builder. Purposeful action is requisite to construction!

In applying the concept of construction to human development, Montessori acknowledges that the method of development does follow a plan of "natural unfolding"; however, development is also determined by the child's "spontaneous manifestations." Indeed, the child's tranquility and happiness, the intensity of his efforts and the constancy of his freely chosen responses . . ." (p. 75) have much to do with his/her progress through the "phases of growth."

Mario (Montessori Jr., 1976) affirms his mother's theory stating that: ". . . human development is the result of an unconscious creative activity of the individual, and . . . this process is only possible in association with others" (p. 6). According to Mario, the child's development --cognitive growth--is marked by his/her significant sparks of learning which are manifested through special sensitivities from within. These sensitivities inherently appear in each of the developmental stages.

Montessori (1967) refers to these stages as sensitive periods for growth and "psychic development" (p. 96). The following sensitive periods (stages) are identified: 1) birth to six, with two substages (birth to three, and three to six), 2) six to twelve, and 3) twelve to eighteen, with two substages (twelve to fifteen, and fifteen to eighteen).

The Sensitive Periods. In the sensitive period of birth to three, Montessori asserts that the adult cannot directly influence the child. This basically holds true for the three to six year old as well, except "in some ways the child begins to become susceptible to adult influence. . . . the personality undergoes great change" (p. 19). For this reason, many countries decide that the six-year-old is ready to begin school.

The second sensitive period (six to twelve) can be characterized as the time of relatively few changes. This child is calm, assured and stable.

But the third period (twelve to eighteen) marks such great changes that development here is almost as drastic as the changes which occur in the first period (from birth to six). In this third period both physical and emotional development undergo such significant changes that by the end of this period, the child is fully developed. Montessori notes that ". . . no further marked changes occur in him. He grows only in age" (p. 20).

It is pointed out that the above three periods also mark the child's structure of schooling: elementary, middle school and secondary school. Montessori notes: "This happens in all countries of the world, so it cannot be a haphazard matter of pure inspiration" that such commonality in school organization exists world-wide. Therefore, whether conscious or not, issues of child development are fundamental to schooling.

The Construction of Knowledge. According to Montessori (1967), the child assimilates the environment through absorption. During the sensitive periods the child is highly sensitive to learning certain things. For example, when the child is in the first sensitive period, he/she is particularly adept at learning language. This does not mean that the child is not able to learn a second language at an older age, only that the effort to learn the language when older is much more strenuous. Montessori explains this process of language absorption by stating that the child absorbs words and their meanings from the environment.

Because he/she has not acquired a store of experiences in memory, the sensorial impressions which are absorbed with language must be integrally constructed by the child. In the first sensitive period this simultaneous integrating of language with sensorial experiences is more easily accomplished.

In continuation, Montessori notes that the impressions which form learning during the sensitive periods are so strong that intense emotion on the part of the child is aroused. In the learning of language, for example, there is "so deep an enthusiasm as to set in motion visible fibers of his body, fibers which start vibrating in the effort to reproduce those sounds" (p. 24).

Finally, Montessori asserts that without freedom to move about and interact physically with the environment, absorption--real learning--would not be possible. She insists that learning ". . . can only be fulfilled through the experience of free activity conducted on the environment" (p. 96). On this premise Montessori's pedagogy is founded.

Implications for Schooling

The ability to concentrate is a thread that runs throughout Montessori's philosophy of learning. Montessori (1956) notes that a child absorbed in the learning is so concentrated, or focused, that he/she is oblivious to occurrences in the surrounding environment. An analogy is used by Montessori to compare a child's learning with the intensity of a scientist becoming "so deeply involved in thought" that he feels "removed from the world itself" (p. 51).

A story is told by Montessori about a four-year-old child who so engrossed herself in an activity that she repeated the task fourteen times without stopping. When the child was finished, rather than appearing to be tired, she seemed to have a renewed burst of energy. Montessori reports that the child "seemed happy, rested and smiling, as children do when they awake to the beneficent sun" (p. 54). This type of concentration was observed by Montessori over and over again, suggesting that: ". . . the concept of order and the development of character, of the intellectual and emotional life, must derive from this veiled source" (p. 56).

Montessori's pedagogy is thus based on the concept of concentration. She asserts that by tapping this inherent resource the "deepest interest" of the child can be sustained.

In regard to the level of the task, Montessori suggests that the teacher respect the child's intuition in such matters by allowing him/her to select whatever captures his/her attention regardless of the task's difficulty level. For the child is "agitated until he seeks something within the depths of his mind that he has not yet found for himself" (p. 61). Great work will come from a child left to find his/her own way with the tasks. It is essential, therefore, that the child not be coerced into doing an activity that is more difficult than one he/she has mastered through concentrated effort. The goal, then, is for nonintervention so that the child may select and pace the learning according to his/her need for absorption.

Order Versus Disorder: Work Before Play. Montessori (1956) asserts that teachers sometimes misunderstand the concept of nonintervention. Upon seeing that a classroom of children's "energies are dispersed in disorder," a teacher may be prone to quietly stand by and allow the confusion. Montessori states that "using the materials completely wrongly" (p. 106) deters opportunities for concentration and learning. At such times the teacher should intervene to establish order.

In this discussion Montessori suggests that using the materials for socializing (play) opposes the goal for concentration. She contends that the Montessori method:

> . . . is essentially based on the ability to recognize the difference among the physical states of the child, encouraging those conducive to his spiritual health (these we can call the good), and discouraging the others, which are neither constructive nor formative and lead to the destruction of his development and the useless scattering of his energies (we call these states evil) (p. 107).

In essence, Montessori is asserting that play reduces the environment to a state of evil in regard to having any usefulness toward the goal of learning. Her proposed "science of education" (p. 115) framework requires that the material things, "objects scientifically selected" (p. 116), be put at the child's disposal for "step-by-step" accumulative experience which can be clarified through adult-child interaction. Child-to-child socializing can only provide a hindrance to this pedagogical process. In sum, Montessori (1949) proposes: "We think the child is happiest when he is playing; but the truth is that the child is happiest when he is working" (p. 93).

Readiness for Learning. According to Mario (Montessori Jr., 1976), a child can be taught any subject at any stage of his/her life. There is, therefore, no need to wait until a child is developmentally ready before attempting to teach him/her. He continues by stating that this thesis of his mother's should no longer be considered a hypothesis for it has been validated by teachers and children using the Montessori method across the world. Affirming these validations, Mario adds that it is a "hopeful sign that scientists have started to take (the thesis) seriously at last" (p. 63).

The reason that the very young child can be taught mathematics or reading, for example, is because of the young child's keen ability to concentrate. Mario proposes that children:

> . . . derive satisfaction from their own activity, which is highly meaningful to them, not from the teacher's appreciation of their work or grades. The acquisition of information is felt to be a discovery. The formation of a new function is experienced as a conquest. The children's egos

> are strengthened, and they develop a love of work . . . (p. 67).

It is because of this great zeal for learning that even very young children can be taught mathematics and reading.

Piaget (1976) directly opposes this contention stating that concepts cannot be understood by a child until the cognitive structures have evolved to the degree, or stage, that such comprehension is possible. As one of three principles listed by Piaget to describe his overall theory, Piaget notes that intelligence can adapt to new learning ". . . in the course of construction of its own structures, which depends as much on progressive internal coordinations as on information acquired through experience" (p. 11).

In other words, experience with new concepts cannot bring about learning for a young child who has not constructed the internal coordinations necessary for making, at the preoperational stage, comprehension possible. As a result, it is futile to teach the preoperational child a concept that requires logical, operational thought.

As stated above, Mario asserts that his mother's method, validated across the world, refutes this claim. The very young child can be taught any subject (i.e., reading or mathematics) which meets his/her interest because of the child's keen capacity for concentration. Indeed, on this point, the two fairly compatible theories of development meet in opposition.

The Montessori Materials. In order to captivate the youngster's attention as he/she encounters learning experiences, Montessori developed specific teaching materials. Each activity is constructed so that a particular learning is met. Mario (Montessori Jr., (1976) notes that the "built-in controls" (p. 69) provide the child on-the-spot feedback so that he/she can know when the procedures are in error. He adds that children ". . . will repeat an exercise time and again with great concentration until they have fully absorbed the principle or concept it illustrates" (p. 69)

A pedagogy which supports waiting for the teaching of reading and writing until the child has reached a particular stage suggests an unnecessary restriction. Four-year-olds can learn to read and write almost effortlessly through a tracing of letters on white paper. Montessori (1966) recalls that when children copied her example of the tracing, and then traced their own letters for sentence making, they would then go off to a corner and try to read what had been written. She adds: "They did this mentally without pronouncing the words" (p. 162). Books were not introduced to the children until many words could be read.

In sum, because of the children's intense concentration on the tasks, and because the tasks led to the attainment of specific skills, children as young as four were able to become proficient readers. The tasks were not only programmed to offer on-the-spot feedback, but they were presented in an order of meaningful sequence. Above all, the tasks were intended for use by silent workers. Montessori (1956) notes: "These lessons may appear strange, because they are carried out in almost complete silence" (p. 103), but the quietness of the lesson signifies that, in fact, it is meeting its instructive purpose.

The implications for schooling, therefore, are that children attending a Montessori school are to work silently on tasks that are specially designed to promote learning. Though the materials have a sequential plan in regard to the level of the task, the children are freely allowed to select from an array of displayed activities. The teacher thus determines what is to be put out for use based on the ascertained level of the children's capabilities. (With the exception of the need for silence, the aspect of selecting one's own tasks to work on is Piagetian in nature.)

It is then proposed that the children will absorb and construct knowledge through their interactions with the things--the materials--in the environment. Through this quiet atmosphere, which provides for student interest with the opportunity for self-selection, it is presumed that concentration will ensue. In concentration, the child will continually repeat the activity until satisfaction, or knowledge, is attained.

Because the goal is for children to be highly absorbed with the learning tasks, social interaction (play) is discouraged. To Montessori, the work is as gratifying as the child could want; evidence of this is apparent in watching a child concentrating on a task. Play in the classroom is thus viewed by Montessori as detrimental, and consequently, evil. Work, on the other hand, is good!

Imagination and Fantasy. Montessori (1966) notes that the child has an inherent unspoiled plan for normal development; that is, to be in the natural state of concentration so that things encountered in the environment can lead the child to cognitive growth. When things in the environment interfere with the child's ability to concentrate, the mind deviates into "aimless wanderings," which, in turn, lead him/her to take "refuge in fantasies" (p. 189). Because the fugitive mind cannot contribute to concentrated learning, things which influence the child to fantasize should be eliminated from the classroom. Montessori states:

> A flight into play or into a world of fancy often conceals an energy that has been divided. It represents a subconscious defense of the ego which flees from suffering or danger and hides behind a mask (p. 191).

It is for this reason that, according to Montessori, the highly imaginative child is not as successful in school as those who are less creative. She continues by stating that ". . . great creative intellects cannot apply themselves to practical matters" (p. 192). The implication, therefore, is that activities which encourage fantasy and daydreaming are detrimental to the growth of children; particularly, to those who tend to show creative tendencies.

Psychic Barriers. It is further noted in Montessori (1966) that children often find learning repugnant when a "psychic barrier", or defense mechanism, is unconsciously acquired by the child. This happens when the child is led to feel incapable by the teacher or his/her peers. Montessori adds that: "Very frequently individuals carry with them through life a psychic barrier that was erected in childhood" (p. 192). This obstacle impedes the child's ability to concentrate and, ultimately, to construct knowledge. The educator is, therefore, cautioned by Montessori about the power of words and what they can do to children. Montessori describes the harmful effects of the psychic barrier with the following:

> There is first a repugnance for a particular subject, then for studies in general, then for the school, the teacher, and the child's companions. There is no longer room for love and cordiality, and the child finally fears school and becomes completely alienated from it (p. 193).

In regard to personal development, the teacher is held responsible for attending to the child's spirit as well as his/her cognitive capabilities. Montessori (1956) asserts that the use of praise and rewards are two ways that teachers trigger unhealthy aspects of development. Indeed, the use of praise and correction lead a child to an unnatural state of dependency.

The child's spirit should not be broken by correction, but neither should it be inflated by praise. A child's response to a situation should originate from internal feelings about the event. Once the teacher has demonstrated the intended use of the materials, it should fall to the child to determine whether the activity proved useful. Independence can, thereby, be fostered.

It is important, therefore, that both the educator and the parent "respect all the reasonable forms of activity" that are undertaken by the child so that his/her energies in all areas can be developed. Montessori adds: "We must believe in all the good that lies hidden in the child . . . " (p. 88).

Herein lies Montessori's concern over children's inference of mistrust. The child's development is not enhanced by manipulations of praise or coercion. The principle of "correcting their inadequacies" (p. 78), for example, instills in the child the need for "being perfect" (p. 79). Discovering that he/she is not trusted by the adult, the child paradoxically looks to the adult for approval in "passive submission" (p. 83). As a result, the child becomes confused; thus, any "opportunity for a tranquil inner development" (p. 83) is defeated. The child's natural tendency for independence is replaced by "passive imitativeness." Finally, the "deepest and most compelling necessities" are left "unfulfilled."

Conclusion

For the Montessorian curriculum, unpurposeful talk, small talk or even praise by the teacher, is avoided. The teacher speaks only when necessary. When first introducing an activity to a child, talk may be appropriate. Even so, it is the physical demonstration of the task that is most meaningful, for inner tranquility is never derived from words. It is paramount, therefore, that the child not be made to rely on feedback in the form of reprimands or praise.

In all, the child's positive response to learning is not won through manipulative words. Real learning must come from the child's exercise of freedom. That freedom, however, is restricted to the parameters of the quiet and orderly conditions that are established for learning. Activity is then self-initiated and self-evaluated and neither praise, nor correction, are used. Such is the Montessori method for fostering the development of young children.

Chapter Conclusions

In this chapter the developmental paradigm has been presented in accordance with the theories of three leading developmentalists: Arnold Gesell, Jean Piaget, and Maria Montessori. Because each of the above became an established member of the natural science community (by way of achieving a doctorate in the fields of biology or medicine), the scientific background of each developmentalist was explored. It was hoped that through such a study, greater insight could be gleaned as to how, or why, each came to propound his/her respective philosophy of development as a finding of natural science.

Beginning with a discussion on the two basic orientations of development (i.e., phylogenetic and ontogenetic), it was stated that a developmentalist will lean more heavily in his/her philosophy to one or the other. In any case, however, both phylogenesis (innate tendencies, heredity) and ontogenesis (a combination of environmental influences and phylogenesis) must have a place in the developmental theory. Otherwise, the theory is not developmental (Munn, 1965).

It can be concluded from the study that of the three, only Gesell holds to a strong phylogenetic philosophy. Piaget and Montessori emphasize the ontogenetic aspect asserting that the human's development hinges largely on the construction of knowledge which is attained through sensorial (physical) interactions with the environment.

With each of the theorists, development is an internal building on of knowledge. Gesell describes this growth in maturational stages (growth gradients), Piaget and Montessori in stages or sensitive periods, respectively. Gesell follows a Darwinian approach to evolution in his theory, Montessori complains that Darwin's theory is too linear. Yet she and Piaget describe development in terms of sequential construction which implies linearity. Furthermore, both Piaget and Montessori reduce their definitions of development to activities that focus on the intellect. Areas of affect (i.e., social development, imagination, fantasies, etc.) are either ignored by these theorists, or disfavored.

The dimension of implications for schooling was added to the discussion of each theorist so that a connection could be made between each of the developmental theories and the manner by which they have been, or are intended to be, carried out into the arena of education. It is of particular importance in this study to explore how these developmental theories have been translated by policy-makers and/or educators for organizational or pedagogical decision-making. Issues of grade placement and retention, self-selection, physical manipulation of objects (as opposed to the receptive processes of merely hearing and seeing), for example, continue on as enigmas of the 1980s!

It was found that while each of the three theorists share common beliefs about the course of development, particularly Piaget and Montessori, significant differences exist among their respective concerns. These differences will be further discussed in the final chapter of this study.

In the next chapter, the reader will be introduced to the transformational theory as espoused by modern physicists and scientists such as 1977 Nobel Prize laureate Ilya Prigogine from the field of chemistry, and physicists Heinz R. Pagels and Fritjof Capra. The reader will also be introduced to the science of Chaos, a paradigm that is emerging across the fields of science. It will be shown that transformational theory is derived from the revolutionary discoveries of Einstein, Heisenberg, and other leaders of quantum mechanics as well as from the science of Chaos. At a later point in the study, transformational theory, rooted in the discoveries of new science, will be applied to human development.

CHAPTER III

THE MAKING OF NEW SCIENCE

According to Gleick (1987), scientists from the broad fields are converging to favor a paradigm shift called Chaos. Its roots, however, stem back to the works of Henri Poincaré and the introduction of quantum physics.

Gleick credits Poincaré as being "the first to understand the possibility of chaos" (p. 46). In studying the laws of motion on geometric forms, Poincaré was the first to consider dynamical possibilities. After his death, however, the concept of dynamical systems "atrophied" to the degree that even Poincaré's name "fell to disuse." Poincaré's work was revived in the 1960s by a qualitative geometrist (topologist) named Stephen Smale.

Like Poincaré, Smale sought a global understanding of the entire realm of geometric possibilities. Turning to dynamical systems, Smale conceived of a range of possibilities that a trajectory, or point, might travel in an oscillator. (An oscillator is a devise which allows the scientist to observe the swings of an oscillating body in phase space; a trajectory that moves from one extreme position to another.)

According to Gleick (1987), Smale combined Poincaré's non-Euclidean geometry with the oscillating screen to create a visual reproduction of the theory in action. Smale's "phase space" used a point to describe the system's as if frozen in time. All of the information about the velocity of the system's movement is contained in the point's position. Thus, in phase space, a change of the system can be ascertained by a movement of the point. As the system makes continuous changes, the point traces a path called a trajectory.

In continuation, Gleick (1987) explains that the trajectory oscillates back and forth on a screen, revealing the dissipation processes. A system dissipates as it takes in, or releases, energy. Smale found that the movement of the trajectory created friction which, in turn, caused the system to lose energy. The trajectory line began to contract "like a balloon losing air" until the point no longer moved.

Discontented with this result, Smale set about to create a pattern that would undergo multiple transformations. He created a structure that ultimately became known as the horseshoe. Through this creation, Smale was able to illustrate the effects of "sensitive dependence on initial conditions" (pp. 51-52). This concept became the crux of the transformational theory. In essence, sensitive dependence acknowledges that minute fluctuations, or disturbances to a localized part of the system, can lead to macroscopic changes in the entire system. Smale's geometrical shapes thus opened for physicists and mathematicians "a new intuition about the possibilities of motion" (Gleick, 1987, p. 52).

The above serves to illustrate how the works of a "rebel" scientist of the early 1900s have come to fruition with the emergence of Chaos. There was no cumulative process, however, for Smale had to rethink and revise not only Poincaré's theory, but also many theories of his own. What the illustration does reveal is that this seemingly new science is not so new at all. Just as Smale drew his theory from the works of Poincaré, the assumptions of Chaos have been derived from a number of science's ghosts: Planck's quantum physics, Einstein's relativity theory, Heisenberg's uncertainty principle, and, of course, Poincaré's non-Euclidean geometry.

Concepts of Chaos

Gleick (1987) introduces the science of Chaos with a discussion of Edward Lorenz's study of weather. Lorenz is described as "a mathematician in meteorologist's clothing" (p. 22). After initiating a computer program designed to illustrate patterns of weather, Lorenz discovered that the trajectory (in the computer screen) followed the course as anticipated, but after awhile, the line began to go off course. In time the movements became even more exaggerated.

The technical name for what appeared became known as The Butterfly Effect. It was so named because the trajectory began to move in and out in such a way as to create the illusion of butterfly wings on the computer screen. Additionally, the concept of "sensitive dependence on initial conditions" entered into the creation of that name with the idea that a butterfly's flapping of wings--creating a tiny perturbation in the air--can ultimately lead to a major thunderstorm in another part of the country.

The trajectory's path is dependent upon the formula that is put into the computer. Lorenz discovered that the trajectory's movement off course was due to the particular formula that he had used. Unexpected rounding of the decimal began to transform the numeral, and ultimately, the path of the trajectory across the screen. In sum, the series of unpredicted roundings led the trajectory to uncharted courses!

Gleick explains that when studying phase space, all knowledge about a dynamical system is collapsed to a single point, the trajectory. The point thus becomes the dynamical system. The value of using phase space lies with the fact that it is easy to detect a change in the system. A system continually comes back to its original state until a fluctuation causes it to move into a loop. Then patterns of motion and details are exposed to the scientist which were formerly undetectable with linear processes. It is, therefore, possible to trace the history of a system using phase space.

Gleick adds that phase space offers scientists the knowledge that "systems with infinitely many degrees of freedom" (p. 137) can never be made known in a precise and definable way. Therefore, absolute predictions will never be available for such systems as turbulent waterfalls, the weather, or the human brain.

Mitchell Feigenbaum's discovery of universality is then introduced by Gleick (1987). Mathematician Feigenbaum's concern was with distortion of perception. At greater distances images lose their meaning and become distorted, blurred, and even lost. The distortions--noise--overrun any details that might provide precise information. This noise alludes to the chaotic messiness of a system. Feigenbaum sought a mathematical formula that might provide the perceiver with those precise details that are, otherwise, muddled with the turbulence.

Feigenbaum ultimately discovered "geometric convergence or scaling." He had expected different formulas to provide different information about the respective entities being studied. Gleick states that such phenomena would include:

> Rolling streams, swinging pendulums, electronic oscillators--many physical systems (that) went through a transition on the way to chaos. . . (p. 114).

According to Gleick, the mechanics of these kinds of systems seemed "perfectly well understood" by the physicists of today; that is, equations had been discovered that provided useful information. Gleick continues: ". . . yet moving from the equations to an understanding of global, long-term behavior seemed impossible" (p. 174). Feigenbaum's scaling theory brought to light that varied entities being studied, with their differing kinds of information, can all be mathematically computed to equal the scaling formula. There is thus a universal formula for describing the nonlinearities of turbulent systems. For unruly systems, the scaling revealed that "some quality was being preserved while everything else changed. Some regularity lay beneath the turbulent surface of the equation" (p. 172).

The most important implication of Feigenbaum's theory was that the equations that physicists and mathematicians used were irrelevant. Once order emerged, the original equation was no longer valid anyway. "Quadratic or trigonometric, the result was the same" (p. 174).

What also seemed to be the same was the manner by which systems emerged: order, to a change of state, to possibly other changes of state--of disorder--to a higher order, and so on. It was the universality of these processes which Feigenbaum's scaling theory detected. In sum, it was mathematically discovered that systems erupt into turbulence in like manner, regardless of the physical type of system (solid, liquid, gas).

The term "period-doubling" is used to identify the system's scaling. At <u>equilibrium</u> a system will reveal a fixed point. Here the trajectory bounces steadily toward the attractor. With the first period-doubling, the trajectory splits apart (bifurcates) into the creation of two fixed points. Though they at first remain together, the two trajectories gradually float apart. At the second period-doubling, each of the two trajectories divide, or bifurcate, so that now the system has four. The bifurcation of the two into the four occurs at exactly the same time! Again, the four trajectories gradually float apart. Upon the third period-doubling, the process repeats itself, and so on.

Feigenbaum's universality revealed that unlike systems have a commonality of behavior, despite the differences that exist among the systems. Gleick (1987) notes, however, that Feigenbaum only studied simple functions. Still: ". . . he believed that his theory expressed a natural law about systems at the point of transition between orderly and turbulent" (p. 180). Gleick refers to Feigenbaum's discovery as being qualitative, quantitative, and structural because it extends from the quality of an observed system to both patterns and precise numbers.

The concept was then applied by Gleick (1987) to Harry Swinney's studies of fluid motion. Here liquid was placed in a spinning cylinder. It was found that at a steady state of equilibrium a speck placed in the fluid moved (oscillated) east and west. When the system picked up speed, donut-shaped rolls formed on the outer edges with the speck moving up, down, out and around the donut configurations. As more speed was encountered, the donuts were losing their shapes and the fluid was turning into chaotic turbulence. At a higher level the system jumped to such a high state of turbulence that no rolls were distinguishable. The system had emerged into a new order. These fluid transformations emerged in the same manner that Lorenz's Butterfly Effect, and Feigenbaum's period-doublings, had illustrated.

Nature was revealing its universal processes in a variety of scientific experiments. In ways such as these, scientists from across the fields are demonstrating that they are coming to be of one accord. It appears that Chaos will, one day, emerge as the triumphant paradigm!

<u>The Terms Defined</u>

In recapitulation, the basic concepts of Chaos are defined below. Along with the ones mentioned above, other concepts presented by Prigogine and Stengers (1984) are included here, but will be further discussed under the section entitled "Chemistry." The primary terms are:

1) equilibrium - the steady state of a system;

2) dissipative structure - an organism, or system, that both takes in and gives off energy, an open system;

3) sensitive dependence on initial conditions - the system's response to initial fluctuations;

4) fluctuations - random movements that disturb the system, perturbations;

5) bifurcation point - the point at which the system splits (bifurcates) or changes into a differentiated state;

6) entropy - noise or messiness that encompasses a system that has been perturbed. Prigogine and Stengers associate entropy with the "arrow of time"; meaning that once a state has been made entropic--changed--it can never return to its former state. The particles and elements do not find their former positions. For this reason, all transformations into differentiated states are irreversible;

7) period-doublings - the manner by which the system scales to differentiated states. Prigogine and Stengers refer to these differentiated states as: equilibrium, near-to-equilibrium, and far-from-equilibrium;

8) scaling (geometric convergence) - the mathematical description of how systems emerge into differentiated states (from equilibrium to chaos); and

9) instability - the result of a fluctuation that is at first localized in a small part of the system, but can also spread to permeate an entire macro-system.

It should be noted that Feigenbaum's scaling theory is in opposition to that of Prigogine and Stengers. These authors assert that the universe is perpetually in a state of nonequilibrium. Theories of universality are, thereby, inadequate descriptions of nature. Prigogine and Stengers (1984) assert that universal constants "destroy the homogeneity of the universe by introducing physical scales in terms of which various behaviors become qualitatively different" (pp. 217-218). These authors add that ". . . 'most' dynamic systems behave in a quite unstable way" (p. 263).

It has previously been noted that Feigenbaum is a mathematician; therefore, approaching the universe quantitatively is his primary occupation. At any rate, it has been suggested that the scaling theory only proves that formulations are unnecessary. For once a system leaves its equilibriated state, the original equation loses its validity. The universality implies, therefore, that the earth's turbulence holds some degree of regularity. That regularity can be described as the processes by which systems emerge into differentiated states.

The most important fact about these two opposing theories is that while they disagree as to the matter of quantifying universality, they agree on the assumptions of Chaos, that the universe is random, nonlinear, irreversible, and uncertain. Kuhn (1970) notes that the umbrella of a paradigm will cover divergent theories, and while there may be points of disagreement, the basic assumptions find congruence. Herein is an example of the difference between a theory (which finds contention between Prigogine and Stengers and Feigenbaum) and a paradigm (upon which they all agree)!

The remaining parts of this chapter present both a field interpretation and a historical perspective on the emergence of the Chaos paradigm. Through this discussion of the founding fathers, alongside the introductions of some contemporaries of the fields, the reader should be able to glean insight into the theoretical underpinnings and implications of the science of Chaos. For it is these discoveries of modern science, which not only comprise the assumptions of the Chaos paradigm, but which also found the transformational theory. In this way, the findings of modern science's collective fields about the nature of the universe are made applicable to the nature of humankind.

A Concurrence in the Fields

According to Prigogine and Stengers, the study of chemical instabilities has crossed the boundaries of chemistry for both "theoretical and experimental work." Institutions and laboratories are conducting, worldwide, research about the random, nonlinear, entropic, characteristics of the universe. The authors contend that the investigations are of interest "not only to mathematicians, physicists, chemists, and biologists, but also to economists and sociologists" (p. 146). A global perspective of Chaos is presented below using scientists from the broad fields. In this way, the processes of transformation in physical systems (e.g., chemical, fluid) can be unveiled.

Chemistry

Ilya Prigogine was awarded the 1977 Nobel Prize for his work on nonequilibrium systems, particularly dissipative structures. These structures are described as open systems which take in, and expel, elements of the environment. Any such system, from a city to a human being, can be considered a dissipative structure.

Prigogine and Stengers (1984) describe the system at rest as being comprised of "hypnons," or independent particles, which "ignore one another" (p. 180) during equilibrium. Because the system is open, its entities dynamically move about in a random fashion. Slight fluctuations are likely to occur within the system at any time. During equilibrium, fluctuations are typically ignored by the hypnons. But on the other hand, it is possible for a single random fluctuation to, ultimately, lead the entire macro-system into disorder. Initially, though, the perturbation is either ignored or restricted to the locality of the fluctuation.

The system could choose to respond to a fluctuation in a more dramatic way. In such a case, the system would undergo a transition into a differentiated state. Should this take place, the new phase would be identified as near-to-equilibrium. The system would thus shift, or bifurcate, into a less coherent, yet still relatively stable, order. The point at which this shift occurs is referred to as the bifurcation point. This point is likened to Feigenbaum's first period-doubling.

The near-to-equilibrium state finds the system in greater flux with increased random occurrences. The hypnons, or "sleepwalkers," have thus been awakened. This near-to-equilibrium phase is important because it paves the way for subsequent transitions, leading the system (organism) on to an irreversible transformation. The authors explicate the process by stating that a "finite perturbation . . . cannot possibly overrun the initial state in a single move" (p. 187). Instead, the fluctuation perturbs the limited region which, in turn, spreads to outside regions. Eventually the entire system becomes invaded as the result of the finite perturbation.

This is described by the authors as a "nucleation" process in which the initial perturbation forces the system to make a choice. The perturbation either crosses the threshold and "spreads to the whole system," or it is ignored by the hypnons and the system. It is only by random action that the system chooses whether or not to transform. At any rate, a return to equilibrium does not bring the system back to its former state. Even in equilibrium, the hypnons "behave as essentially independent entities;" thus they move about dynamically. Once disturbed into a differentiated state though near-to-equilibrium, a return to equilibrium could never bring those dynamic entities back to their former routes or positions.

Whereas the primary bifurcation introduces only a minimal amount of disturbance to a localized area within the system, it bears significance for two reasons: 1) it forces the system to choose its future direction, and 2) it paves the way for a transformation. But how the system will choose cannot be predicted. Prigogine and Stengers note: "There is an irreducible random element; the macroscopic equation cannot predict the path the system will take" (p. 162). Thus, once the "original bifurcation has disappeared," a structure may emerge "continuously as the bifurcation parameter grows," or it may "be attained only through a finite perturbation" (p. 164).

It is here that Prigogine and Stengers disagree with Feigenbaum; it cannot be universally predicted that a perturbed system will emerge into chaos. However, Prigogine and Stengers refer to Feigenbaum's theory as a way to describe how a system does emerge into chaos, once that path has been chosen. The authors describe the "Feigenbaum sequence" as a "remarkably simple road to 'chaos'" that describes a range of parameters that exist between bifurcation jumps for systems demonstrating periodic behavior.

Prigogine and Stengers contend, however, that systems are free to choose their future states, and this aspect cannot be predetermined. Thus the authors assert: "There is no longer any universally valid law from which the overall behavior of the system can be deduced" (pp. 144-145). Because each system is a unique case, an investigation of a system's behavior may show qualitative differences from that which might be universally expected.

In accordance with the transformational theory, therefore, the behavior of dissipative (organismic) structures cannot be predicted. But once the system has elected to bypass the threshold and jump into a more differentiated state (i.e., perform the second period-doubling), a higher level of entropy, or messiness, is thereby attained.

Pagels (1982) defines entropy as: ". . . a quantitative measure of how disorganized a physical system is, a measure of its messiness" (p. 101). The concept is explained by Pagels with the following illustration. A blending of the right amounts of salt and pepper into a container of water will, at equilibrium, present an organized state of water and particles. Shaking the container will increase the level of entropy, or messiness, within the container. Profuse shaking will, on the other hand, increase the entropy to such a degree that the solution turns gray.

Prigogine and Stengers concur with Pagels that once the entropy has increased, the transformed state will never be able to return to its original organization of segregated salt and pepper particles. Even at mild entropic levels, systems are irreversible; the salt and pepper particles can never return to their original positions once shaken.

Prigogine and Stengers refer to this concept as the "arrow of time" with the inference that time--entropy--is only one-directional. Though history is incorporated into the present and future, it can never reappear. The authors state that the past and future play different roles, and even with the inclusion of the past into the present, "the future remains uncertain" (p. 289). Systems are not only irreversible, they are also uncertain and unpredictable!

The authors note the nonlinearities of a system: ". . . life seems to express in a specific way the very conditions in which our biosphere is embedded, incorporating the non-linearities of chemical reactions and the far-from-equilibrium conditions imposed" (p. 14). Once the system has bifurcated to a state of far-from-equilibrium, it has, through possibly multiple period-doublings, transformed itself into a significantly differentiated state. Furthermore, the system has "self-organized" itself into a higher, more refined level of coherence.

Now that these processes have been uncovered by modern science, the scientist has a more complete knowledge of "life and evolution." It is understood that the fluxes of randomness allow the system to burst forth into limitless opportunities for growth. Because the decision to choose rests with the system itself, its paths are not predictable and, consequently, they turn out to be nonlinear.

The far-from-equilibrium state is organized because: ". . . the amplification of a microscopic fluctuation occurring at the 'right moment' result(s) in favoring one reaction path over a number of other equally possible paths" (p. 176). And given a choice, a system (organism) will always seek growth and improvement, higher organization.

When applied to the human as an organismic system, it can be surmised that the person has a decisive role in leading to his/her transformation. Because the transformed state is a higher form of self-organization, the human is provided, by the science of Chaos, hope for a brighter future!

Physics and Mathematics

According to Hillner (1984), eighteenth century German philosopher, Immanuel Kant, is "credited with initiating the modern phase of metaphysics" (p. 85). Nonetheless, Kant's philosophy has met with wide controversy in the emergence of quantum theory.

Kant distinguished between the noumenal (objects and things/events of human experience), holding that the contents of the noumenal world are unknowable because they have not been experienced or acted upon. Space, time and causality are phenomenal because they do not exist in the noumenal realm of concrete objects; instead, they exist in reference to one's experience. Even so, space, time and causality are "a priori" because they must, at least intuitively, exist prior to the person's experience. Thus, according to Kant, the phenomenal categories of space, time and causality are "logically and temporally prior to experience." Hillner adds: "We cannot have experience or structure without them" (p. 86).

Hillner continues by stating that the space and time categories were defined by Kant according to Newton's laws and Euclidean geometry. With the discovery of Einstein's "probabilistic" relativity theory, Kant's philosophy came under wide dispute among the scientists.

In his autobiography, Heisenberg (1971) states that the impact of Kant's philosophy on quantum physics was an issue for discussion at a Leipzig conference in the early 1930s. Among the scientists who were there, Kant's philosophy was debatable to the degree that no consensus could ever be reached. Some asserted that Kant's interpretation of the causal laws could not be shaken; that the new quantum theory was opposing Kant's laws, and that they intended to "fight the matter out" with the quantum theorists. The scientists opposing the quantum theorists suggested that Kant's causal "a priori" is vital to the future of science, and that all research must be guided by the causal laws. Heisenberg considered their position as food for thought.

Modern physics became severed from its classical ties of Newton's causal laws and Kant's "a priori" philosophy by such discoveries as Einstein's relativity theory and Heisenberg's uncertainty principle. It was the findings of these and other quantum physicists in the early 1900s, and Poincaré's theory of bifurcation processes, that ultimately paved the way for the emergence of Chaos and the transformational theory.

Interestingly, one of the founding fathers of this new anti-causal science, Werner Heisenberg, was a proponent of Kant, despite Kant's adherence to Newtonian ideas. Additionally, the new science's most heralded founder, Albert

Einstein, never relinquished his hold on the classical philosophy. It is thus paradoxical that these two far-sighted revolutionaries held on to their classical orientations, particularly in the case of Einstein who never recognized how his discoveries shattered classical science (Capra, 1982). Because of their significant contributions to modern science, the following discussion focuses on Heisenberg, Einstein, and others whose early discoveries transformed the field of physics.

Heelan's (1965) study on the philosophy and work of Heisenberg suggests that Heisenberg was largely influenced by "Kant's transcendental method of philosophy," despite the fact that Kant was "sympathetically disposed" to the "acceptance of universal and necessary scientific laws." Heelan expresses concern over Heisenberg's "peculiar dependence" on the "Kantian philosophy of classical physics."

Because of Heisenberg's leadership in the field of quantum mechanics, his deference to Kant seems contradictory. Heelan thus speculates: "If the Kantian starting point is mistaken, if science presupposes no universal or necessary principles then there is no problematic . . ." (p. 140). But Heelan continues by stating that Kant's emphasis on causality, a category of "substance," fails on the quantum level. He suggests that Heisenberg implicitly held on to Kant's theory of causality even after the discovery of quantum mechanics. As a result, Heisenberg "was dominated uneasily by an idealistic (or positivistic) empiricism" (p. 141).

By the late 1950s Heisenberg showed a change of direction in how he interpreted the Newtonian nature of Kant's philosophy. Contrasting Kant's theory with the quantum discoveries, Heisenberg (1958) notes that space and time have come to be regarded as uncertain and unpredictable, largely as a result of Einstein's relativity theory and his own principle of uncertainty. The relativity theory revealed to the world that the "hidden parameters" of space and time "can never be observed" (p. 135).

Having worked for Heisenberg as "an unpaid 'post-doc'" student, Weisskopf (1972) recalls the remarkable era of the early 1900s when Planck gave birth to the quantum theory, and then Einstein announced, in 1905, his "special relativity theory," followed by his "general relativity theory in 1916." Weisskopf adds: "Among the great systems of ideas which were created in that period (from 1900 to 1930), relativity theory--special and general--has a place somewhat different from the others" (p. 72).

Capra (1982) provides clarification of both Einstein's relativity theory and Heisenberg's uncertainty principle. A third principle, the notion of complementarity introduced by Niels Bohr, also impacted the quantum movement. Each is discussed below.

Einstein's theory of relativity focused on the behavior of subatomic particles which float about the nucleus of an atom. The major finding of Einstein's work is that the sub-atomic particles can have a dual nature. They can behave like waves, or they can behave as particles, depending upon how the scientist chooses to observe them. As a particle, the entity is confined to a small space whereas, when looked upon as a wave, the entity may be spread across a vast region of space.

Einstein referred to the particles of light as quanta, hence the name quantum theory arose. The term photon is now used in place of quanta. Capra (1982) further explains that the electron is neither particle, nor wave; rather, it takes on the properties of either a particle or wave when defined as such by the scientist doing the observation. This means that the entity undergoes "continual transformations from particle to wave and from wave to particle" without having "any intrinsic properties independent of its environment" (p. 79).

It should be added here that this moving back and forth from wave to particle, and then from particle to wave, does not imply reversibility. Capra (1982) explains, for example, that the movement of a particle can cover a four-dimensional space-time continuum. The mathematical expression of this process using "four-dimensional maps" or "space-time diagrams" reveals that these movements "have no definite direction to them." Therefore Capra states:

> . . . there is no 'before' and 'after' in the processes they picture, and thus no linear relation

> of cause and effect. All events are interconnected, but the connections are not causal in the classical sense (p. 89).

It can be seen that the wave-particle question does not allow for a deterministic conclusion since the entities are relative to the conceptions of the scientist, the one doing the perceiving.

While the formula remains the same, it is the problem and the interpretation that differ; thus, it is the human doing the perceiving that actually makes the difference. Therefore, Einstein (1950) asserts: ". . . we must make up our mind to accept the fact that the logical basis departs more and more from the facts of experience" (p. 96).

This dual nature of the quanta, as being relative to the perceiver, leads Einstein to address the issue of simultaneity. According to Einstein, the theory of relativity demonstrated that "simultaneity was relative and depended upon the frame of reference" (p. 105) of the perceiver. Specifically, the quanta is both--a wave and a particle--at the same time. This new discovery was able to free physics, according to Einstein, from the classical notion that "independent physical properties" had to be concealed in "an inertial system" (p. 106), a system at rest, in order to be studied.

Specifically, Einstein (1955) notes that Newton's laws presumed systems to be physically objective and inertial, or, at rest. This was objectionable to Einstein for two reasons: 1) inertial systems "conceive of a thing (the space-time continuum) which acts itself, but which cannot be acted on," and 2) "classical mechanics exhibits a deficiency . . . to spaces of reference which are not in uniform motion relatively to each other" (p. 56). Rather than having to move about with clockwork precision, Einstein suggests that the entities of time and space move about in a nonlinear manner that is neither uniform, nor predictable.

In describing his special relativity theory, Einstein explains that material particles are able to move about freely within a finite region. The general relativity theory then postulates a sequel, that the "symmetric" and the "anti-symmetric" constituents that reside within a sub-atomic, "infinitesimal displacement field" are able to "transform independently of each other, i.e., without mixing" (p. 145). Again the transformation is relative to the perceiver and whether the person chooses to view the entities as particles or waves. Hence, to Einstein, the law of the universe is relativity; that is, phenomena (that which is observed) are relative to the intent of the observer.

Capra (1982) notes that Einstein was striving to create a unified theory that could serve as a bridge between quantum and classical physics. Thus, rather than to build a new science, Einstein sought to correct and refine the old. Capra adds that despite the many compatible studies that supported Einstein's rejection of classical mechanics, Einstein reserved allegiance for that day when classical and modern ties would bind the two as one. That day never came.

In fact, Einstein's wish met with defeat in 1965 by John Bell who found that classical science cannot account for the hidden variables of the universe (Pagels, 1982). Ironically, it was Einstein's own relativity theory that prevented the merger from taking place. Thus, without even his knowledge, it was Einstein who paved the way for the science of Chaos.

According to Weisskopf (1979) the greatest value of Einstein's theory rests with the fact that the quantum state forms an "indivisible whole" until it is "attacked by penetrating means of observation" (p. 120). The quantum state is the state of the system at equilibrium where the atom "adjust(s) itself to the conditions at low energies." Here the atom's movement spreads throughout the region in the form of a wave. Because the atom cannot be observed in its precise movements, the quantum state reveals only an approximate location of the atom, either at rest as a particle, or in flux as a wave moving about the spread of the region. Since "the exact point cannot be predicted with accuracy" (p. 121), Heisenberg's uncertainty principle becomes important.

The uncertainty principle formulates the velocity and position measurements of the electron. The scientist may be studying a million atoms in the same quantum state, the ground state of equilibrium. Even if the velocity of each atom were measured, one could not arrive at the same result, although "the atoms are supposed to be in identical quantum states." Weisskopf explains that the uncertainty principle says that no matter what state the atoms are in, the "product of the spreads" must be greater than Planck's famous constant for the mass of the electron. This numerical value is a "probabilistic spread" that is relative. It is big enough to let the scientist know whether to "decide between the wave and the particle picture of the electron" (p. 121). To use the formula, the scientist must be dealing with a large number of systems that are in the quantum state.

Because dynamical entities cannot be isolated and measured with precision (as classical science would have it), the scientist must deal with probability spreads and obtain only an approximation of reality. It is for this reason that the universe is uncertain and cannot be determined as predictable.

Heisenberg (1971) recalls how, in the late 1920s, he and Bohr spent a great deal of time discussing magnitudes of "time averages of energy, momentum, fluctuations, etc." (p. 76). Neither of the scientists could reconcile with a mathematical formula the "trajectory of an electron in a cloud chamber" (p. 77). Finally, in February of 1927, Bohn went skiing in Norway leaving Heisenberg to tackle the problem alone. Both men had previously believed that "the path of an electron in the cloud chamber could be observed," but the problem was not being solved because, Heisenberg came to realize, they had been asking the wrong question. Thinking back on some prior discussions with Einstein, Heisenberg came to see that what he and Bohr had been observing had not been what they thought, it had been something else. They had been observing individual water droplets which were too large to be electrons. Heisenberg recognized that the question should have been:

> Can quantum mechanics represent the fact that the electron finds itself approximately in a given place and that it moves approximately with a given velocity, and can we make these approximations so close that they do not cause experimental difficulties (p. 78).

A brief calculation found that Heisenberg could resolve the dilemma through the conceptualization of approximations. In this way he applied Einstein's theory of relativity to a mathematical formula--the uncertainty principle--which supported the thesis that if one directly observes the electron by casting light on it, the true course of the electron's path becomes distorted. But by calculating its path through the uncertainty principle, the electron's path can be found through approximations without distorting the truth.

Neils Bohr described the relation between the particle and the wave as "complementarity." Capra notes that, according to Bohr, both conceptions--the wave and the particle--are needed to account for the full reality of the atom. Weisskopf (1972) adds that Bohr was so fascinated by the wave/particle paradox "that he tried to apply it to some other aspects of human thought" (p. 59).

One of Bohr's examples dealt with the problem of free will and the awareness of freedom in decision-making. Bohr saw a complementary relationship between freedom and decision-making; they are separate, and yet vital to complete the whole of human autonomy. A causal connection exists only in that one can decide because the person has freedom, and because the person has freedom, he/she can decide. Just as the particles and waves are the same phenomena seen from two distinct perspectives, freedom and decision-making are also two distinct functions, but of the same phenomenon. One cannot exist without the other; freedom and decision-making go hand in hand!

To recapitulate, up to this point it has been pointed out that mathematician-physicists Einstein, Heisenberg, and Bohr have laid the foundation for the emergence of Chaos through the theories of relativity (special and general), and the principles of uncertainty and complementarity. Particularly through the revolution of relativity, and its counterparts of uncertainty and complementarity, modern science has come to recognize that nature does not function in linear, sequential ways. Instead, nature tends to comprise random occurrences on nonlinear and uncertain paths. Because this is the case, much of the future cannot be predicted with precision, though the scientists have derived means of arriving at some degree of anticipation through statistical approximation. Finally, the existence of entropy, and its relation to emergent transformations, has led modern science to realize that the nature of the universe, and all that it encompasses, is irreversible.

Three additional mathematicians have played a significant role in the founding of these assumptions. In his 1913 response to Planck's paper on quantum theory, Poincaré (1963) affirms the contention that systems emerge suddenly into differentiated states as opposed to going through slow evolutions. According to Poincaré:

> . . . we are thus led to the following statement, more precise than that of Mr. Planck and not, I believe, contrary to his idea.
>
> A physical system is capable of only a finite number of distinct states; it jumps from one of these states to another without going through a continuous series of intermediate states (p. 85).

Poincaré notes that a system behaves in equilibrium until a fluctuation causes it to bifurcate, or "jump," from one trajectory to another "under the influence of neighboring points . . ." (p. 86). But he adds that it is also possible for the system to remain unaffected by the perturbation and, thus, to remain in its only finite number of possible states" such as that described in 1984 by Prigogine and Stengers as a state near-to-equilibrium. With this description of the bifurcation processes, Poincaré does, as Gleick suggests, surpass Einstein and the other early quantum theorists in explicating the transformational theory.

Also in 1913, Poincaré published The Foundations of Science (Poincaré, 1946) in which he questions the propositions of analytic logic which are filled with "antinomies," or contradictions. These laws of science have "a very precise meaning when it is a question of a finite number of objects" (p. 484). But, Poincaré asks: What about the infinite unknown entities of nature that cannot be observed? He proposes: "The old logistic is dead" (p. 485).

As it actually happens, systems transform because the unseen, "innumerable multitude of molecules . . . at high speeds, cross and crisscross in every direction." Poincaré describes the law of deviation causing non-touching entities to jump, or bifurcate, with the following: The molecules probably respond to one another even at great distances, but because of the space that exists between two entities far apart, whatever impact might occur is not detectable by the scientist, thus "their trajectories remain sensibly straight." When, however, two molecules happen to pass nearby each other, then "in this case, their mutual attraction or repulsion makes them deviate to right or left" (p. 523). In this sense, the impact need not be a coming into contact; only that the two molecules' mutual attractions "become sensible." The law of deviation thus applies to molecules that "approach sufficiently near to each other" to reveal a bifurcation of the trajectory. At such a time the scientist can observe an unexpected jump off the course of the anticipated, charted, path.

Poincaré insists that these "disorderly impacts" (which may, or may not, come into physical contact) can emerge into an inescapable chaos of extreme disorder before re-establishing "a sort of mean order" where the system can recover. In conclusion, Poincaré acknowledges the impossibility of obtaining an "exact calculation according to this theory" (p. 526). It is necessary, therefore, to arrive at an approximate calculation.

Another mathematician who paved the way for the science of Chaos was Hermann Weyl. Physicists such as Heisenberg (1971) were fascinated by the writings of Weyl. Heisenberg's mentor, Arnold Sommerfeld, encouraged Heisenberg to begin his studies on a more basic level before embarking upon the theories of Weyl, which Sommerfeld referred to as "the most difficult part" (p. 16) of a mathematical pursuit! Later, friend Wolfgang Pauli told Heisenberg that Weyl "really does know a lot about relativity theory" (p. 25).

One of the impressive aspects of Weyl's writings is his emphasis on the transformational theory, particularly in regard to entropy and the influence of chance, or random, factors. These bear upon the irreversible changes that befall a system or organism.

In Weyl (1949), the state of thermodynamic equilibrium is discussed in a macroscopic context. Weyl acknowledges that although spontaneous occurrences to a system might be improbable, they can quickly disrupt the system's equilibrium and produce an irreversible change. For example, the "spontaneous density fluctuations of the air," diffract the sunlight to the degree that the sky is made to appear blue instead of black. Thus, however "minute" those fluctuations might be, "they still have an observable global effect."

Weyl adds that "chance appears to prevail whenever 'little causes lead to big effects'" (p. 200).

Specifically, Weyl cautions that minute deviations can perturb a system beyond human control by gradually penetrating a global area. Furthermore, some transformations can "lead to fatefully different results" (p. 200). And entropy is a condition that, as it increases, the system is led to further transformations. Weyl notes, for example, how the stirring of coffee and milk leads, at first, to a state of disorder, followed by a differentiated state that is both ordered and irreversible. This new and ordered state would never have been created had the original particles not been stirred by a perturbation.

In contrasting quantum mechanics from classical physics Weyl (1932) notes that in the classical era, physicists defined the nature of something by the quantity that could be derived from its measurement. Attributes were then assigned to the object on the basis of laws that had been postulated. In fact, it came to be such that attributes were assigned to an object "independently of whether or not the measurements necessary to establish them were actually carried out" (p. 54). Logical formulations using connectors such as <u>if</u>, <u>then</u>, and <u>and</u> allowed the classical scientist to methodically postulate assumptions and conceal attributes of the phenomena under study.

The new insight of quantum mechanics enables the scientist to determine the probability of a system's taking on a particular quantity when those values that are possible are known. However, "knowledge of the states of two parts of a system by no means fixes the state of the whole system" (p. 55). A system is too dynamic to be defined by a localized segment. In fact, a system has far-reaching possibilities beyond what can be seen in the classical sense, for "the whole is more than the sum of its parts" (p. 55).

Weyl is suggesting that "the concepts of Gestalt of the Whole" (p. 56) offer the scientist an opportunity to see beyond the reductionistic functions of the Newtonian machine-works to transformative functions which are "not additive." These assumptions parallel the philosophy of humanistic psychology which seeks to understand through the Gestalt (Heider, 1973; Mahrer, 1978).

In sum, Weyl (1932) is suggesting that a system, whether it be inorganic or organic, derives its whole--its transformed or developed state--from an interactive, but not additive, "understanding" of its elementary particles. Transformation, in fact, occurs prior to and independent of any control exercised by a classical scientist seeking to regulate through positivistic laws. In opposition to the classical stance, Weyl provides a global depiction of quantum theory and its relation to nature and life. Weyl suggests:

> It seems therefore that the quantum theory is called upon to bridge the gap between inorganic and organic nature; to join them in the sense of placing the origin of those phenomena which confront us in the fully developed organism as Life,

> nature to which atoms and electrons are also subject (p. 56).

From the above, it can be seen that Weyl was a holistic thinker of the 1930s.

Finally, the third mathematician of importance to the emergent Chaos paradigm is Erwin Schrödinger (1945) who refers to the transformation from one state to another as a "quantum jump" (p. 49). Using mathematical language, Schrödinger states: "Considering the entire irregularity of heat motion, there is no sharp temperature limit at which the 'lift' will be brought about with certainty and immediately" (p. 51). According to Schrödinger, the "lift" (bifurcation) can occur at any temperature other than absolute zero. But the higher the temperature rises, or deviates from zero, the greater the chance of an unexpected jump.

It should further be noted that Schrödinger's reference to zero as being incapable of bringing forth a transformation is because zero is the point at which the system has no entropy. Schrödinger states: "At the absolute zero point of temperature . . . the entropy of any substance is zero" (p. 72). Without entropy, the system is at equilibrium. The hypnons ignore not only each other, but also many of the fluctuations that could perturb the system (Prigogine and Stengers, 1984).

In sum, Schrödinger, like Weyl and Poincaré, recognizes the transformative processes of nature's inorganic and organic systems. These processes are integrally woven with randomness and nonlinearity. Transformations remain uncertain because it cannot be predicted when or how such bifurcations might occur; and finally, the transformations are irreversible. The following section presents an affirmative view of these Chaos assumptions as applied to cosmology.

<u>Astronomy</u>

Lovell (1958) states that the universe originated from "a dense and small conglomerate" which Abbé Lemaître referred to in 1927 as "the primeval atom" (p. 88). All of the material of the universe was originally contained in that primeval atom. At some point in time, however, an "initial momentum of the expansion dispersed this material" (p. 89). This is commonly referred to as the Big Bang!

Because the "initial impetus of the expansion" nearly exhausted the elements of the universe, these entities quickly settled down into a "nearly static condition" of equilibrium in which the forces of gravity and cosmic repulsion were kept in balance. Once the explosion dispersed the entities into space, this first state found the celestial bodies in balance at equilibrium.

After a long time of being at equilibrium, the primeval material began to form into great clusters. Hence the condition of equilibrium changed to a state of near-to-equilibrium.

Then the cosmical repulsion forces "began to win over those of gravitational attraction," and this launched the universe into a far-from-equilibrium expansion. At this point solar systems and galaxies emerged throughout the universe.

The above processes of expansion have brought the universe to the state that is known today, but the universe has only been in its present state for the past nine million years. A few thousand million years ago, the universe was only about 1/10 of its present size. It is not possible for science to know when the condition of the primeval atom began. Lovell notes that the primeval atom theory "does not determine this with any precision," however, the atom's explosion must have occurred "between twenty thousand million and sixty thousand million years ago" (p. 90). Therefore, this last phase of nine million years which has formed the present galaxies has been a relatively recent era in the universe's vast history. Most importantly, the Big Bang theory illustrates that since the primeval explosion, the universe has undergone a series of transformations.

In The Cosmic Code, Pagels (1982) proposes that today, the most widely accepted view of the universe's origin is the "big bang model" which "maintains that the entire universe originated in an enormous explosion" (p. 279). In accordance with Lovell's description of the theory, Pagels suggests that all of the universe's matter--today's stars and galaxies--was, at one time, combined into a concentrated, in fact very confined, region of primordial soup (i.e., the primeval atom). The primordial soup underwent a rapid expansion that resulted in a tremendous explosion. Pagels continues:

> In so doing it cooled down, enabling nuclei, then atoms, and finally much later galaxies, stars, and planets to condense out of it. This explosion is still going on today, except that the universe is much colder now as it expands (p. 280).

Whereas it was once believed that atoms are stable, Pagels asserts that quantum theory has now come to the conclusion that "stable nuclei will decay" (p. 284); thus, atomic particles are not actually stable. However, only a probability for this conception can be given. Even though a decay might ultimately take place, Pagels suggests that it is still possible to conceive of how a primordial soup of atoms, could "spontaneously turn itself into a fireball of quarks, leptons, and gluons--the big bang" (p. 284). Many scientists hold to the contention that the universe is decaying and will, ultimately, wither away. Even the human, after his/her ultimate transformation, is destined to die.

The second law of thermodynamics provides the basis for this rationale (Prigogine and Stengers, 1984; Pagels, 1982). Capra (1982) states that the disorder, or entropy, "will keep increasing until, eventually, the system reaches a state of maximum entropy, also known as 'heat death'" (p. 74). It must be noted, however, that the scientists are not in agreement over the future of the universe. Many proponents of the transformational theory support the assumptions of entropy until it reaches the state of maximum entropy. At this point, the scientists divide. Capra adds that modern biologists often oppose the notion that organisms resort to decay; rather, their transformations continually lead to "states of ever increasing complexity" (p. 74). It must be suggested, therefore, that the notion of the universe "running down" to a halt is not a matter of congruence, even among modern scientists.

Both Lovell and Pagels support the theory that the universe transformed to an intergalactic field of stars, galaxies, and constellations when the heat from its original atom(s) surpassed the threshold for stability. In affirmation, Sciama (1959) suggests that the heavy elements (i.e., stars) are built up by heat. When the elements become unusually hot they are distributed throughout the milky way through "varying degrees of violence which these stars are known to undergo" (p. 212).

Once the star has lived so long that it begins to outgrow its heat and cool down, it is no longer able to hold out against its own gravitation. Consequently, the star contracts. The system--the star--is once again perturbed. This, in turn, causes the star to transform to an even differentiated state because its "temperature rises again." According to Sciama (1959), the transformations occur as the star (the system) cools down and contracts. This creates a friction against the surrounding elements which, in turn, leads the star to rise again in temperature. As the temperature rises, "thermonuclear reactions" occur. Sciama adds:

"These new reactions release so much energy that the contraction is stopped" (pp. 213-214).

Once the contraction has stopped, the density within the star becomes greater than the density of the universe surrounding the star. Sciama thus proposes: "It is now quite a frequent occurrence for two particles to strike the helium nucleus simultaneously, so that it jumps the barrier at mass 5" (p. 214). When the helium has completely burned, the cycle repeats itself by cooking and then contracting. At this point, the transformative process has reached another bifurcation point (Prigogine and Stengers, 1984).

In continuation, Sciama (1959) notes that the process of transformation has not come to an end. As the cycle repeats itself from heating, to cooling, to contracting: "more thermonuclear reactions can occur, the energy release of which stops the contraction." In time the bifurcation to a state of far-from-equilibrium emerges. Here Sciama states that: "This time the elements are built up all the way to iron. The building-up process stops there because iron is the most stable of all the elements" (p. 214). Thus the violently exploding stars, called the supernovae, have ejected from within themselves elements that are "heavier than iron" into the surrounding space. These new stars do not turn back into iron (their former state) because:

> to do so each nucleus would first have to pass through a configuration of <u>higher</u> energy. When the heavy elements are dispersed in space they have no means of obtaining this extra energy, so they just persist indefinitely (p. 214).

Whereas Lovell and Pagels emphasize the Big Bang from its inception, and briefly discuss the bifurcations, Sciama deals in more depth with the universe's present state of affairs. It is proposed that in the beginning, the universe was confined into the primeval atom (or primordial soup). After the explosion, the universe manifested a rapid expansion of intergalactic galaxies, stars, (i.e., systems) which have continued to bifurcate and produce new transformations on both macroscopic and microscopic levels.

Sciama's discussion focuses on the smaller systems of the universe, the supernovae (stars). It appears that a star transforms through cycles of heating, cooling and contracting. When the bifurcations have led the star to such a temperature that it explodes and ejects matter to form new stars, these newer elements are unable to return to the former composition that was capable of attaining high temperatures. Thus, the new stars are heat resistant. For this reason, they are stable and "persist indefinitely." The newly formed stars are, therefore, transformations of the original supernovae, but in a higher entropic state.

Sciama (1971) closes by stating that the "Newtonian theory of gravitation" can no longer describe these circumstances. However, "most physicists believe that the correct theory to use is Einstein's general theory of relativity . . ." (p. 8). It can be seen that Poincaré's theory of jumps--that the system leaps from state to state in a noncontinuous and unpredictable manner--also fits Sciama's description of entities transforming in the cosmos.

Pagels (1982) concludes that there is no absolute law governing the universe and all that exists therein. By noting the patterns--the transformations--which are characteristic of all facets of the universe, a better understanding lies close at hand. Because of the uncertainty that pervades all of the cosmos, Pagels is compelled to state: "Until the final chapter of physics is written we may be in for lots of surprises" (p. 287)!

Biology

In The New Biology, Augros and Stanciu (1988) relate the findings of modern physics to biology noting that a chief function of the human sciences is to study the mind. In regard to development and the growth of knowledge these authors suggest that the building-blocks theory must be abandoned. The components of the mind, at each level of development, are potential and not actual. According to Augros and Stanciu: "The higher form is new and different, not a mixture or a compounding of lower forms . . . . The higher form actualizes the potentiality of the lower form (p. 38).

In regard to formulations of developmental hierarchies, Augros and Stanciu contrast the living being to an inorganic crystal. They note that crystals increase in size as matter is externally added on. In the crystal's evolving growth, "no transformation of substance" from the inner being exists. A perfect crystal is thus homogeneous. But "living things grow from within" (p. 42). Thus the authors propose:

> The key to the living thing is the excellence of its agency. An organism can change itself; it can act or not act on its own initiative . . . (p. 43).

In contrast, inorganic substances are always at the mercy of outside fluctuations; that is, they weather or rust, etc. There is no internal activity to set the nonliving thing into motion, it cannot choose.

The importance of this passage rests with the notion that human development is internally constructive, and largely under the control of the person as he/she chooses for the self. Unlike a chemical or fluid system, for example, when confronted by fluctuations, or perturbances of life, the human need not be at the mercy of a threshold or boiling point. Augros and Stanciu emphasize that: ". . . . we ourselves are the key to understanding life and living things. Taking man as the exemplar for biology . . . all levels of nature are reflected in him" (p. 83). And this aspect of self-selection--acting in one's fullest sense of agency--is vital to the human.

Just as the modern physicist supports the quantum theory, the modern biologist proposes the transformational theory (i.e., the assumptions of Chaos). This is because the transformational theory presents the developing human as an agent who grows through purposeful action. The human first sets a goal, knowing that another could be substituted in its place (if so desired), and then chooses, as freely as possible, the means to achieve the desired end. The will is, therefore, the human's primary agent for it sets the intellect into a particular course of direction, and even overrides emotions that interfere with the attainment of the goal. A person will thus ignore basic health needs to satisfy the goal, or dominant will. Only a "nonmechanical model" can provide for the full range of developmental processes (i.e., sensation, emotion, intellect, will) that encompass the human being.

Whereas will might have much to do with the human's road to development, this is not to suggest that random, unexpected occurrences do not upset the path, forcing the human to explore alternate, nonlinear routes. Neither do these theorists suggest that the person, despite his/her will, can control or be certain of the destiny--or end--that is desired by the goal. This is because development is subject to the circumstances of randomness, nonlinearity, irreversibility, and uncertainty; therefore, development is never precisely predictable.

As emphasized by the physicists, mathematicians, etc., development, along with many facets of nature, can be approximated. Augros and Stanciu describe a biological path of evolution and development that approaches the assumptions of Chaos while opposing the Darwinian theory of evolution. This path to development is referred to by these authors as the "process of systematic differentiation" (p. 184).

The theory of systematic differentiation first recognizes that change occurs through potentialities that develop from within the person. The human is able to grow in his/her potentialities because he/she has the capacity for being self-directed. It is up to the person to choose. When one neglects this vital aspect of life, he/she interferes with the progress of his/her own development. Secondly, development "operates by jumps." The authors contend that these jumps have been substantiated by organisms "producing new species immediately" in experimental laboratories. The third point is that neither evolution, nor development, is perpetuated through the use of competition, or "natural selection" as postulated by Darwin. In fact, biologists have discovered that evolution occurs through "a cooperative effort of the whole population." As the fourth point, the authors state that despite the sudden jumps, the evolution/development is "a natural, orderly process that plays out the possible variations on a theme, nature here acting like a creative artist." Fifth, there exists in the process a principle of economics that seems to guide the evolving/developing being as the individual seeks to proceed with "minimum energy, minimum material, and minimum waste." Finally, for the sixth point, Augros and Stanciu add that "systematic differentiation really produces new species, and <u>in a way that can be duplicated in the laboratory</u>" (pp. 185-186). In this way the authors seek to emphasize that, though theoretical, systematic differentiation has been empirically validated through research. Furthermore, this "new biology" bears ecological significance finding "unity at many levels" (p. 228). Systematic differentiation thus brings to the fore an "Anthropic Principle" that nature is in harmony with all living systems--human and animal--asserting purpose through physical, social, material, and cultural processes of development.

The Theory of Evolution

In systematic differentiation studies scientists have worked to adjust a species to a changing environment through "polymorphism" to prevent is extinction. The plant/animal's color, shape, or metabolism is changed to give it flexibility in adaptation. In the late 1800s a dark moth was rare, but with the advent of industrialization trees became darkened by the pollution, leaving the white moth to be easily found by its predators. Now dark moths make up nearly 100% of the moths in particular areas. Augros and Stanciu note:

> Polymorphism . . . is not a mechanism of evolutionary novelty; it is a mechanism of stability that helps to maintain a species once it is established (p. 179).

The major events of evolution take place because of the programs/patterns built into the regulatory genes. The body is built according to these genetic programs that are carried by every cell to each part of the body. However, many cells also have particular duties to perform (e.g., muscle cell, nerve cell). For these cells, the genetic information is suppressed so that the genes can fulfill their needed functions. Structural genes "code for the production of single proteins" (p. 180). It has been found that many different organisms have similar structural genes. The difference between organisms, then, must rest in how this like information from the structural genes is used. Using a molecular approach, scientists are studying cells' deoxyribonucleic acid (DNA) regarding the sequencing of the genetic programs that are in the regulatory and structural genes. The purpose is to uncover what it is that organisms use from the codes in the genes.

Augros and Stanciu note that it has just recently been discovered that plants and animals use only a tiny portion of the DNA in the cells for building the organism. Most of the information is "superflous." The authors suggest:

> It is possible that within this superflous DNA some process develops new regulatory gene patterns that eventually produce new body plans and hence new species (p. 181).

It is emphasized that species--progenitors--do not change into new species; rather, they "harbor superflous genetic material" that can serve as the seeds for new species to develop in subsequent generations of offspring. There is a long developmental period in which genetic changes are being made in the coding system, yet no evidence is coming forth in the individual's who comprise the parent species. Nor is it known how long these developmental periods exist, how many generations are needed before the changed progeny is born. The authors note:

> When a new species finally appears, suddenly and fully formed, its progenitor (parent) continues without change. Evolution occurs only in species' superflous and unexpressed DNA without changing the individual organism or the extant population (p. 182).

Pagels (1982) affirms these findings suggesting that evolution is part of the indeterminism of quantum theory. According to Pagels, ". . . a few random changes in a DNA chain (are) producing a successful mutant" (p. 112-113). Ferguson (1980) adds that because living things strive to perfect themselves, it is conceivable that the "cell periphery in a living organism actually feeds information back to the DNA at its core, changing the instructions" (p. 161). She proposes that evolution is a "re-forming of the basic structure, and not a mere adding on."

In light of these findings, Augros and Stanciu contend that Darwin's survival of the fittest model "does not square with observation" (p. 89). Numerous documentations describe animals in the wild which have actually avoided competition to cooperate with other species for survival. The authors asserts that while "two species never occupy the same niche" (physical space/occupation), in thousands of cases it has been found that "similar animal species coexist without competing because they eat different foods or are active at different times or otherwise occupy different niches" (p. 93).

The theme that is emphasized by these authors is that nature's inhabitants are able to coexist in peace and cooperation. Innumerable instances of coexistence and cooperation between different species has astounded modern biologists observing the subtle and varied types of interdependence that nature's wildlife has revealed. The authors state that this phenomenon of cooperation and coexistence "constitute(s) one of the most intriguing subject areas in all of natural science" (p. 105).

Animals do not fight over the environment; instead, "they work with it or around it" (p. 137). While some animals seek to evade a drought, others make provisions to survive through it. In either case, no animal is foolish enough to attempt to confront a drought head on. The authors continue: ". . . none is foolish or inefficient or wasteful in its life plan. Neither do organisms waste energy struggling against the wind" (p. 137). Thus from a biological perspective, neither animals, nor humans, are out to annihilate and conquer the remainder of their species. Such behavior is not only highly taxing upon the individual being, it is self-destructive. No species can survive for very long in total isolation: "No organism, then, contradicts its habitat" (p. 138).

Furthermore, Augros and Stanciu assert that ". . . the paleontological data do not agree with the predictions of Darwin's theory" (p. 166). In The Origin of the Species, Darwin (1936) predicts that the fossil record will find evolution to be a slow and successive progression of changes. Though Darwin acknowledges the variations, he does not believe that they can occur in sudden or spontaneous jumps. According to Darwin:

> As natural selection acts solely by accumulating slight, successive, favourable variations, it can produce no great or sudden modifications; it can act only by short and slow steps (p. 361).

In this way Darwin describes evolution's path to transformation as a sequential (linear) and ordered (with short, successive steps) route. To further this argument, Darwin adds:

> Why should not Nature take a sudden leap from structure to structure? On the theory of natural selection, we can clearly understand why she should not; for natural selection acts only by taking advantage of slight successive variations; she can never take a great and sudden leap, but must advance by short and sure, though slow steps (p. 144).

Harvard biologist-geologist Stephen J. Gould (1977) counters Darwin's stance with the following:

> I want to argue that the 'sudden' appearance of species in the fossil record and our failure to note subsequent evolutionary change within them is the proper prediction of evolutionary theory as we understand it (p. 61).

Gould, therefore, asserts that evolution exists, but not in the manner by which Darwin proposed. Sudden leaps do occur! Gould continues: "Evolutionary 'sequences' are not rungs on a ladder;" rather, the evolution of a species is the sudden "splitting of one lineage from a parental stock--not by a slow and steady transformation of these larger parental stocks" (p. 61). And this bifurcation, Gould adds, is a rapid process that can only be understood in retrospection.

Two additional points about the fossil record are made by Augros and Stanciu. For one thing, ". . . species typically survive for a hundred thousand generations, or even a million or more, without evolving very much" (pp. 169-170). It has further been discovered that even those species which ultimately became extinct held incredibly long histories in the fossil record before dying off. Secondly, once a transformation takes place, its appearance is not only rapid, but also nonlinear. Augros and Stanciu assert:

> Whole new orders appear suddenly and simultaneously, with no evidence of intermediate stages. These sudden burst of flora and fauna, so typical of the fossil data, are called radiations since the ancestral stock develops at one time many new body plans and diversifies in several directions at once (p. 173).

The authors note, for example, that about fifty million years ago, mammals suddenly bifurcated into "about twenty-four different orders ranging from bats to whales, kangaroos to elephants, and rodents to rhinoceroses. This pattern is not peculiar to mammals" (p. 173). It is believed that rapid radiation from the cosmos had much to do with the sudden transformations.

In sum, Darwin's impetus is to promulgate the survival of the fittest theory with its implication of competition over cooperation. The prediction for evolution is thus postulated by Darwin (1936): ". . . natural selection acts by life and death--by the survival of the fittest, and by the destruction of the less well-fitted individuals" (p. 144).

For this reason, Darwin is criticized by Augros and Stanciu, Gould, and other modern scientists who have come to find nature more harmonious, with cooperation being the dominant theme of the world's species. Gould notes: "Natural selection is the central concept of Darwinian theory--the fittest survive and spread their favored traits through populations" (p. 40). But Gould further notes that to Darwin, improvement does not mean a higher state in a metaphysical sense. The fact that a wooly mammoth grows hair to adapt to changing cold "is not progressive in any cosmic sense;" therefore, ". . . natural selection is not a doctrine of progress" (p. 45).

Nor does Darwin's evolution support the assumptions of Chaos--transformational theory--which describe the change to a differentiated state as a transformation to a higher order. It is the principle of entropy that suggests systems seek higher organization.

Augros and Stanciu find Darwin's theory to be "epitomized by three concepts: competition, inefficiency, and gradualism" (p. 177). It has been found, however, that nature operates under a uniform principle of economics. In reference to quantum physics the authors suggest that water flows downhill because inanimate systems seek to expend the least possible amount of energy. By the same token, living things seek economical ways to survive and develop. Augros and Stanciu conclude the discussion by asserting that: ". . . nature is not wasteful and inefficient. The noncompetitive relation between species observed in nature follows from the more universal principle that nature operates in the most efficient, economical way" (p. 177). And in closing the authors note: "This general premise is empirically supported by every natural science."

The following section looks at the philosophy of Alfred North Whitehead whose writings stem from the early 1900s when quantum physics was being introduced to the scientific community. Whitehead's philosophy bridges the gap between the principles of quantum reality and implications for humanity.

A Philosophy of Science

Whitehead (1925) describes nature as an "interplay of bodies" which remain in flux, "disclosed to us as one complex of things" which constitute a "systematic totality" (p. 209). The large bodily event of the system is affected by the "intimate character" of the relations which reside within. Specifically, the outcome is such that the whole is affected by the parts. Additionally, the reciprocity that exists between the parts and the whole of the human, extend beyond the human so that there is also a reciprocity between the human, as a part, and nature, as a whole.

Within the human, molecules modify themselves to contribute to the pattern, or body, as a whole. The parts within that pattern "are peculiarly sensitive, each to the modifications of the other" (p. 214). Events interact within the body through a process of "emergent enduring" patterns; the aim is for growth and stabilization. Modern physics provides innumerable examples of this process. Because this seems to be a universal principle of interaction, that systems and organisms cooperate to attain a higher order of wholeness, Whitehead (1925) states:

> The laws which condition this field are nothing else than the conditions observed by the general activity of the flux of the world, as it individualises itself in the events (p. 220).

Whitehead views the functions of an entity within the organism as having a substantial role in the body's overall health. An isolated entity's mode of activity reveals the organism's peculiar, or selected, response to a flux externally imposed upon that entity in the organism. Though the body is confronted by infinite fluxes, it has the possibility of choosing whether, and how, it might respond, depending upon the modes, or capabilities of the various parts. Whitehead contends: "Each individual activity is nothing but the mode in which the general activity is individualised by the imposed conditions" (p. 255). It is this modal differentiation that enables the parts to interact for the good of the whole.

Whitehead (1934) suggests that the internal workings of the body's entities function in a nonlinear manner. This is because the human's immediate experience is, in part, derived from a multiplicity of prior experiences which enter into his/her understanding of the present experience. By the same token, anticipations of future experiences play upon both present and past experiences. The nonlinearity of these overlapping processes refutes the notion that nature runs on a cause-effect track. Whitehead (1934) asserts: ". . . each happening is a factor in the nature of every other happening . . . . no event can be wholly and solely the cause of another event" (p. 41). Whitehead (1957) adds that the human's present and past lose the "single determinate meaning" (p. 109) that each respectively entails as past perceptions and feelings become diffused into present durations.

In sum, the bodily event is such that the whole is affected by the parts. Through nonlinear processes that enable the human to integrate the past with the present, and with anticipations of the future, the human responds to the fluxes of the environment with "emergent enduring" patterns that stem from the body's repertoire of modal capabilities. Because of these inherent attributes, the human can respond to the random perturbations of the environment by choice.

This chapter has introduced the new science of Chaos as an emergent paradigm which actually had its inception in the early 1900s with the discoveries of Planck, Einstein, and other physicists who introduced quantum mechanics, and with mathematician Henri Poincaré who introduced the processes of transformation. The assumptions of the transformational theory were presented throughout the chapter as they pertain to the new paradigm of Chaos and the fields of chemistry, physics and mathematics, astronomy, and biology. Finally, the philosophy of Alfred North Whitehead was presented as a philosophical integration of science with the human organism.

In the following chapter the humanistic paradigm is explored in relation to the assumptions of the transformational theory. It is shown that this perceptual, Gestalt philosophy views development accordingly.

CHAPTER IV

THE HUMANISTIC PARADIGM

In studying the works of prominent humanistic theorists, the researcher discovered that the humanistic philosophy tends to concur with the transformational theory. It was found that these theorists believe that human organisms choose to make order out of the disorder of their lives.

Hillner's (1984) historical description of humanism suggests that this "Gestalt-oriented holistic" paradigm became regarded as the "third force" of the 1960s and 70s because it challenged the prominent paradigms of psychology: behaviorism nor psychoanalysis regarded man as unique; and each made the organism a prisoner of uncontrollable forces." Humanism, on the other hand, ". . . placed man at the center of the psychological universe and put man back in control of his own destiny" (p. 238). Through this psychology the human was made responsible for both the actions and the consequences of his/her choices. In sum, the human became responsible for his/her own well-being.

This emphasis on individual choice and responsibility that one must accept in accord with one's choices provides a strong link between humanism and existential theory. Hillner states that ". . . the American existential psychologist, Rollo May" (p. 234) played a significant role in the laying of groundwork for the humanistic paradigm. Assisting in this endeavor were "pre-1960 humanists," Donald Snygg and Arthur Combs.

Humanism also developed from a number of psychology's specialized fields (e.g., psychoanalysis, Gestalt), as well as from philosophy's existentialism, Hillner notes that "there is no widespread consensus relative to exactly what humanism is." It appears, however, that humanism represents a return to the search for consciousness. Although Gestalt concepts are included, humanism extends from mere perceptual awareness to encompass "the organism's entire personality or state of being" (p. 234).

There is no question as to humanism's roots in existential theory. Leading existentialist and proponent of humanistic theory, Rollo May (1983), defines existentialism as ". . . the endeavor to understand man by cutting below the cleavage between subject and object" (p. 49). The term existentialism, May notes, is in reference to the science of ontology which is "the science of being (<u>ontos</u>, from Greek 'being')" (p. 51).

After recognizing the contributions of Edmund Husserl, Heidegger, and Jaspers to the advancement of existential thought, May concedes that the basic philosophy which founds existentialism is an inherent part of other similar philosophies. According to May (1983):

> There is an obvious similarity between existentialism, in its emphasis on truth as produced in

> action, with the process philosophies, such as Whitehead's . . . (p. 55).

Furthermore, existentialism has a striking resemblance to Eastern philosophies such as "the writings of Laotzu and Zen Buddhism." May's point is to note the global congruence that exists between a number of philosophical orientations which are "not at all to be identified; they are on different levels." In suggesting that existentialism and humanism are attempts to understand the human, May (1983) adds: "The present widespread interest in Oriental thought in the Western world is, to my mind, a reflection of the same cultural crisis . . . which called forth the existential movement" (p. 59).

It can be seen, therefore, that May acknowledges the possibility of developing, or attaining fulfillment, through a variety of approaches, with existentialism being only one. The implication is such that a wide range of orientations (e.g., the assumptions of Chaos, Whitehead's philosophy, existentialism, humanism) can all be of one accord when it comes to supporting the transformational theory.

The researcher found numerous occasions when the humanistic psychologists made reference to randomness, nonlinearity, irreversibility, and uncertainty or unpredictability in regard to the fluxes, or processes, of nature. Many such citations are presented in this chapter. It will be shown that the humanistic paradigm and the assumptions of Chaos are theoretically congruent, even if, as May suggests, the two perspectives are "on different levels." Some theoretical considerations that, in fact, bear out the congruences between the humanistic paradigm and the transformational theory follow.

The Newtonian-Deterministic Rationale

Allport (1961) asserts that conventional descriptions which tend to categorize a person's development through stages are mere abstractions which ignore the inner qualities that make humans unique. Such theories ignore, according to Allport:

> . . . how John's intelligence is related to his dominance, to his values, to his conscience, and to everything else in his personality, it is the 'inside system' that baffles a conventional science of universals (p. 10).

Stage theories ignore the "inside system" and thus cannot adequately explain development. Instead of seeking to understand the dynamic complexities of the human upon which development impends, stage theories are invented to identify and abstract from the human common characteristics which can be used for comparative purposes. Deterministic science is baffled by the anomalies of human uniqueness. Kuhn (1970) proposes that scientists view exceptions to the rule to be "just too problematic to be worth the time" (p. 37); therefore, the anomalies are ignored.

The Newtonian deterministic science does not address the affective nature of the human. By ignoring the complex and unique personality of the human, the singular focus which frames development into a rational, cognitive context allows the human to be defined in a narrow and linear way. Allport (1961) surmises:

> We have made some progress in manufacturing building blocks (traits) and in labeling them, but little progress in architecture . . . . as yet we have few methods to help us establish these ideas on a scientific basis (p. 386).

But Allport (1955) also notes that "the individual's possession of multiple possibilities" prohibits the deterministic scientist from knowing more than "simplicist" solutions. According to Allport: "One-channeled minds can never comprehend that truth may have many channels" (p. 85).

Maslow (1970) affirms Allport's contention, noting that "orthodox science . . . leave(s) out too much that is precious to most human beings" (p. 40). Moreover, deterministic science finds ways to classify the human personality into any number of artificial routes that might support whatever it is that the scientist seeks to verify. Maslow (1987) suggests: "Perhaps we shall have to reject atomistic classification and look for some holistic principle of classifying . . ." (p. 229).

May (1983) asserts that a proponent of the scientific method employs "philosophical presuppositions" to serve as the "spectacles through which he perceives" (p. 46) the object of study. This technique is used regardless of whether the determined variables of study even encompass the "real problems." The scientific method tends to focus on isolated facts "from an allegedly detached base." May contents that this technique:

> . . . arose out of the split between subject and object made in the seventeenth century in Western culture and then developed into its special compartmentalized form in the late nineteenth and twentieth centuries (p. 46).

Furthermore, May admonishes America's preoccupation with methodology to the neglect of searching for hidden considerations that impact the bits that are analyzed. Maslow (1970) affirms by stating that: "Nineteenth-century objectivistic, value-free science has finally proven to be . . . a poor foundation for . . . the rationalists, the humanists, and other non-theists . . . (p. 40)

Rogers (1969) notes that while data collection and the ability to "postdict" behavior is possible with the scientific methods, it is "doubtful that it could ever collect and analyze the data instantaneously" (p. 292). Because the human is continually in flux between the ongoing processing of information which must be both cognitively and affectively addressed, it is impossible to rationalize the person's behavioral response. Therefore Rogers (1977) expresses concern over the fact that the rationality of science is an "attempt to divorce the two actually inseparable components of experience, to the detriment of our humanity" (p. 50). There must be no distinction between the cognitive and affective aspects of the human.

A New Science Proposed

Snygg and Combs (1949) point to the fact that the "behavior of conscious living organisms is irregular and variable, and relatively unpredictable" (p. 341). As a result, people who experience "the same physical situation" do not respond or behave in the same manner. These authors add:

> And, what is even more confusing, in the same physical situation the same person behaves differently at different times. In terms of the physical environment, the behavior of living organisms is erratic, irregular, and relatively unpredictable (p. 341).

This is because behavior is determined not by an objective reality, but by one's subjective feelings about the object (or objective environment) which is perceived.

Combs, Richards and Richards (1976) propose: "The perceptions that might be available to a person at any moment are practically infinite" (p. 412). However, a professional clinician is often able to arrive at an "approximation" of one's possibilities for the future by coming to "understand the meanings which constitute a person's experience of his world" (p. 412).

The emphasis of the humanistic paradigm, then, is upon understanding as opposed to measuring. In affirmation, Allport (1955) asserts that "psychology is a nonnormative discipline" which must discover an individual's "course of becoming" by "dealing with the whole fabric of personality" (p. 101). Only then may one's potentialities of greater promise be opened for consideration.

For the above reasons, Maslow (1987) submits that a new approach to science be launched. Whereas the "means-centered orthodoxy" allows the scientist safety and security from challenges of the profession, normal science methods force the scientist to participate as a mere "settler." Unfortunately, the call is for pioneers, not settlers, to explore the "not-yet-known." Maslow reiterates with the following:

> The proper place for scientists . . . is in the midst of the unknown, the chaotic, the dimly seen, the unmanageable, the mysterious, the not-yet-well-phrased (pp. 192-193).

Moreover, because science has become so method-bound and independent of human values, there is "no way to distinguish between an important experiment and an unimportant one . . . the most trivial research could demand as much respect as the most fruitful one" (p. 193).

Rogers (1973) affirms the need for viewing the human in a nonrestrictive way be describing human evolution as a "fluid valuing process" which affords opportunities to freely choose "whatever he deeply values" (p. 201). Human behavior need not conform to rigid linear expectations. Instead, one will chart his/her own course in accordance with the "actualizing and socialized" goals that one inwardly assumes in his/her "growth promoting climate." Rogers, therefore, proposes:

> . . . when the human being is inwardly free to choose whatever he deeply values, he tends to value those objects, experiences, and goals which make for his own survival, growth, and development, and for the survival and development of others (p. 201).

It is assumed that as one develops towards health (the actualization of his/her growth needs), the choices that one makes tend to contribute to the health of those around him/her. As a result, one's own survival and health also enhances the survival and development of others. Kelley and Faunce (1945) reiterate: ". . . consider the way in which we multiply our individual resources when we cooperate with others" (p. 26).

Kelley and Rasey (1952) affirm Rogers' contention about the fluidity of development noting that "the human organism in its totality and all that it encounters is in flux" (p. 20). The complexity of life centers on the fact that "there is constant change in relatedness." How individuals change in their relatedness to one another and to the environment is a concern that normal science cannot approach. Because humans "live in a milieu of movement," science must consider all the fluctuations that perturb the human as he/she attempts to relate to this world of perpetual change. To these authors: "Life, then, really means process, movement, flux" (p. 20).

Rogers (1969) contends that development is compounded by many "irreconcilable contradiction(s)" (p. 274). But even in an oppressive environment, a person can draw from his/her capacity for "self-understanding" to make meaningful choices.

In an interview with Evans (1970), Allport urges that ". . . all these factors . . . be accounted for when we attempt to determine how personality becomes what it is" (p. 53). Self-image, maturation, cognition, identification must all be considered in understanding the personality. It is added by Allport that self-image is a factor that affects development long beyond the years of childhood.

Finally, May (1975) asserts that a vital part of development encompasses the aspect of transformations which must not be ignored by science. May first addresses the transformation of the adolescent into adulthood which brings the young man/woman to "a new form." It is then emphasized that not all transformations are physiological. Here May describes a transformation in his own life that completely and permanently altered his thinking--his personal theory--about human nature.

In this transformation, May came upon an anomaly which he first discarded because it did not contribute to the hypothesis of his study. Because the phenomenon kept presenting itself, May encountered a period of stress. He spent time reading and contemplating over what might be the solution to an impossible problem. Finally, one night May put away the materials of his study and left his office with the intention of thinking of other things. As he allowed his mind to roam freely (contemplating the green houses that he passed on the way to the train), a sudden insight overcame May's consciousness. This heightened awareness brought May to a different plane of consciousness regarding the theoretical phenomenon.

In this way May became psychologically (as opposed to physiologically) transformed. From the moment of that sudden insight (transforming heightened awareness), May has approached the subject of human development from a different consciousness than that which previously guided his research.

From the above humanistic theorists it can be surmised that a new approach to science is needed for endeavoring to understand the multi-faceted conditions (anomalies/ fluctuations) that intervene in one's course of development. Influences of objective and conscious experiences that play upon one's subjective and unconscious feelings prohibit normal science from approaching reality. The following pages illustrate how the theorists of the humanistic paradigm recognize that randomness, nonlinearity, irreversibility, and uncertainty/unpredictability are implicit aspects of development which appear in the dynamics of transformation.

The Humanistic Paradigm of Development

Kelley and Rasey (1952) describe the human as a "unit of energy seeking to spend itself" (p. 22). Approaching the human from a physics perspective, the authors note that the basic unit of all organic and inorganic matter is the atom which "is not a solid particle but an organization in which energy is locked" (p. 23). Because the smallest unit--the atom--is comprised of moving particles, all matter is energy. Nonliving matter (e.g., rocks) expend energy in the course of deterioration, withering away. Living matter, on the other hand, has a natural tendency to spend energy for the sake of self-preservation. The human organism, in particular, has a degree of control over how its energy will be spent. Thus humankind has the inherent capacity for choice.

Inorganic materials spend energy in such a way as to transform themselves from a state or order into pulverulent disorder. Humans, on the other hand, transform from disorder to order. The authors add that when growth is arrested and the transformations cease to occur, development can be decelerated to the point at which death ensues. Hence one either grows, or one ultimately dies.

Unlike plants and animals, the human has highly developed capacities through the refined and complex nervous system. Humans thus have the capacity to remember, to foresee, and to somewhat create their own destiny. However, the authors note: "There are still many conditions which he (the human) has not been able to control completely . . ." (p. 26). In continuation, Kelley and Rasey note that the weather is an example of one kind of condition which lies beyond the realm of human control. Still the human can invent such things as heaters and air conditioners to modify the effects of uncontrollable phenomena such as the weather.

Finally, humans have a need for others. It is a misconception to think that competition is the key to survival. According to Kelley and Rasey, biological research has shown that "the fundamental methods of progress for living things is not competition, but cooperation" (p. 28). Just as an infant must depend upon its mother for nourishment and sustenance, "an individual life depends upon the cooperation of separate individuals" (p. 29). Humans, as well as plants and animals, find symbiosis (i.e., different species living together for mutual advantage) to be requisite to survival. The authors conclude: "Man, then, is a social creature or he is nothing" (p. 30).

From these considerations of growth and development the humanistic theorists espouse a philosophy that seeks to encourage humanity on toward psychological health and fulfillment. Humanism recognizes that precise measurement and prediction impose parameters which restrict the scientist from considering the many unknowns that encompass the human's growth and development. The theorists, therefore, address issues relative to these unknowns which often parallel the assumptions of Chaos. In fact, the humanistic paradigm seems to suggest that development encompasses: randomness, nonlinearity, irreversibility, and uncertainty/unpredictability. The following pages present some particular examples of the apparent congruences between the humanistic paradigm and the assumptions of Chaos.

Randomness

Kelley and Rasey note that humans are continually in flux as they experience and interact with constantly changing circumstances of the environment. These everchanging situations leave the individual feeling "like a fish swimming upstream." Kelley and Rasey explain:

> There is no other fish in the world exactly like this one, and the flowing water that he strives with carries ever different other fish and debris for his attention or for his ignoring. The banks and the bottom of the stream, the swiftness of the current, the temperature of the water, are continuously different and continuously carry the potential of 'for better or for worse' (p. 47).

By the same token, the human strives to develop in "this inevitable and inescapable stream of life" continually trying to relate to the ongoing changes that exist among the people and events. Like the fish in the stream, the human is perpetually confronted by the randomness of events and circumstances over which he/she has no control. Many such occurrences can be neither anticipated, nor can an internal (emotional) response be offered in one situation as it might in another. It appears that randomness can be applied not only to the external factors of chance, but also to the internal response that one might experience on a given day. (On any other day, the individual might react in a different manner.)

In addition to the above, the concept of randomness can be applied to the context in which May (1975) describes sudden insights; thoughts pop into a person's head from, seemingly, out of the blue! May asserts that such bursts of insight come from a "breakthrough of ideas from some depth below the level of awareness" (p. 55). The heightened awareness is thus a coming into consciousness of unconscious thought. May adds that this explains why people who share a common experience will have varying ways of interpreting that experience. Each individual draws from his/her past experience which is often forgotten on the conscious level, yet remains alive in the unconscious.

Maslow (1962) notes that for the person who "becomes more stable and autonomous," many of the random occurrences of life "will make no change at all" (p. 36). Once a person has developed beyond the level of striving to meet basic needs (i.e., safety, belonging, love), he/she becomes more and more able to reject perturbing fluctuations that upset fragile, less developed persons.

This is not to imply that a person who has developed to the degree that his/her potentials are more fully actualizing ever reaches the point in life that anger, frustrations, trials and tribulations do not make some impact. Maslow asserts that all people experience pain and conflict. The more fully developed individuals, however, often seek to grow from such experiences by turning "inward in a meditative way" (p. 35). Thus the actualizing persons tend to resolve conflicts through self-searching as opposed to seeking help from others.

In continuation, Maslow lists the kinds of random perturbations that tend to lead less developed persons into therapeutic treatment. Traumas and tragedies such as conversions, sudden insights, and deaths are often found to have "forced change in the life-outlook of the person and consequently in everything that he did" (p. 36). It can, therefore, be surmised that random occurrences may be minor enough to an individual that the perturbation is ignored. Similarly, a random fluctuation might cause a person to seek out a resolution through self-reflection, or meditation. As Kelley and Rasey, in addition to Maslow, suggest, the response to a random occurrence will not be the same for individuals who are confronted by even the same situation. Because of individuals' differing levels of development and unique prior experiences, randomness can describe the anomalies that exist both within and external to the existence of humankind in the universe.

Nonlinearity

In his interview with Evans (1970), Allport proposes that "a direct linear cause and effect relationship" (p. 77) between events in one's life and the person's subsequent response cannot be made. For example, "there is nothing predetermined about what values the child will acquire from its parents" (p. 77). Allport attributes this nonlinear relationship between the input of parental instruction and the output of behavior as being the randomness of life itself. Allport expresses this with the following:

> . . . it seems to me that all the interesting things in personality lie in the inferences we must make about what's going on in these intervening variables in terms of motivation, interests, attitudes, values, and so on (p. 14).

The unknowns, which implicitly exist in a world of randomness, prohibit the legitimacy of conjecturing about cause and effect relationships. Abstracted generalizations offer little in regard to indicating the nonlinear possibilities that enter into one's behavior.

Even Maslow (1962), with his hierarchial plan for development (which takes one from the gratification of basic needs to the healthier state of self-actualization) suggests that: ". . . the stepwise, all or none, saltatory conception of motivational progression toward self-actualization" is to be discouraged. Rather than to gratify needs "one by one, before the next higher one emerges into consciousness," the goal for self-actualization must be viewed as "a dynamical process, active throughout life, Being, rather than Becoming" (p. 24). Development is dynamic, and thus, nonlinear.

Rogers (1977) describes the highly developed person as fully-functioning, Maslow (1962) uses the term, self-actualized, and Combs et al. (1976) refer to the person has having a positive view of self. In Combs (1982) such a person is characterized as: 1) being knowledgeable, 2) seeing him/her self in positive ways, 3) having deep feelings of identification with others, and 4) being open to experience. The concept of openness, in and of itself, implies nonlinearity. Combs conveys the inherent nonlinearity by stating that: "Greater openness . . . to experience means persons have more data from which to make choices" (p. 107).

In essence, the randomness of data is dynamically being processed by the perceiver who selects from an array of possibilities a path of choice. As previously stated, the dynamics enter into the process on the basis of how the person elects to respond on a given day. (On any other day, it is possible that the person might opt to choose differently, depending upon other intervening variables that might present themselves at that particular time.) Indeed, the more open one becomes (in receiving and responding to fluctuations), the more nonlinear the person's processing of the information, and active response, turns out to be.

Combs (1962) adds that persons who have a positive view of self "behave in terms of what seems best to do, and let the chips fall where they may" (p. 53). A nonlinear approach to life thus enables the person "to be creative, original and spontaneous." Combs reiterates:

> With a positive view of self one can risk taking chances; one does not have to be afraid of what is new and different. A sturdy ship can venture farther from port. Just so, an adequate person can launch himself without fear into the new, the untried and the unknown (p. 53).

In this context, being "adequate" means having a positive view of self, or psychological health.

May (1969) recognizes the nonlinearity of development in the emotional realm of human relations. According to May, "in all stages of human development the experiences of love and death are interwoven" (p. 103). Caring for another human being is a process of being open to feel and identify with the other person's pain and joy with empathetic, heartfelt concern. May emphasizes: "Care is a state in which something does <u>matter</u>; care is the opposite of apathy"

(p. 289). It is paramount that this realm of feelings and emotions be included in conceptualizing human development. As May points out, ". . . we cannot know except as we feel" (p. 303). The affect is, most assuredly, the human's most nonlinear area of development.

But May does not restrict his theorizing to the affective area; he also addresses cognition. It is important to note that the humanistic psychologists do not segment the areas of human functioning into categories (i.e., cognitive, affective, psychomotor). However, development is often viewed as a function of separate entities. Therefore, it is being noted here that the humanistic psychologists do not restrict themselves to singular aspects of development. (Piaget, on the other hand, considers only the cognitive realm of development. And Gesell concerns himself with only biological maturation.)

May (1975) notes the nonlinear fashion by which thoughts leap about in one's cognition. According to May:

> The human imagination leaps to form the whole, to complete the scene in order to make sense of it. The instantaneous way this is done shows how we are driven to construct the remainder of this scene. To fill the gaps is essential if the scene is to have meaning (p. 131).

An illustration of how the cognitive function is integrated with the affect is presented below. First May notes that as the human thinks about things of interest, he/she organizes those thoughts into a form. It is then pointed out by May that the term "form" is problematical. He continues that if only the word from were used: ". . . it would sound too abstract; but when it is combined with passion, we see that what is meant is not form in any intellectual sense, but rather in a wholistic scene" (p. 131). Cognition and affect are integral to one's coming to make sense of his/her experiences. In sum, cognition cannot be devoid of affect.

Because thinking and learning are as much affective (emotional) processes as they are cognitive, Rogers (1977) proposes that education encourage teachers and students to participate in discussions that invite open and free expression of feelings and concerns. This, of course, encourages the underlying aspects of randomness (individual thoughts and emotions) to surface in a nonlinear fashion. Rogers' open format for teaching offers the students opportunities not only to express themselves freely, and to choose, but it allows each individual the "freedom to be" (p. 74).

Both Combs (1982) and Rogers (1977) address the importance of establishing an open climate in the classsroom. By facilitating an openness to experience, Rogers (1962) cautions:

> I do not mean that this individual would be self-consciously aware of all that was going on within himself, like the centipede who became aware of all his legs. On the contrary, he would be free to live a feeling subjectively, as well as be aware of it . . . (p. 25).

The point is that one cannot develop fully without the removal of inhibitive barriers. Rogers and Combs propose that the classroom is one place where such barriers can be let down.

The reader may note that the concepts of randomness and nonlinearity do not comply with exclusive categories. In fact, the concepts are highly indicative of overlapping. It is for this reason that discussions of randomness appear in the section on nonlinearity. The following sections on irreversibility and uncertainty/unpredictability also illustrate the holistic and integral nature of the science of Chaos.

Irreversibility

According to Kelley and Rasey, human development is a forward-moving process. One might reach a plateau in his/her development, but it is impossible to return to a former state. These authors propose that in development, "the plant, the animal, the human being becomes more perfectly that which it already is" (p. 61). May (1969) affirms that development must encompass more than just a sustenance of life. Using the biological concept of tropism which describes an organism's tendency to turn toward life sustaining elements of nature (e.g., light, oxygen), May asserts that it is not the will, but the wish to live that "moves us." In other words, tropism inclines one toward life-sustaining elements (e.g., food, light, shelter). However, the mere sustaining of life, by meeting only basic needs, can offer a person no more than a meager state of existence until life's inevitable termination comes to pass. May (1973) thus projects:

> The human being cannot live in a condition of emptiness for very long; if he is not growing <u>toward</u> something, he does not merely stagnate; the pent-up potentialities turn into morbidity and despair, and eventually into destructive activities (p. 143).

Prigogine and Stengers (1984) refer to the principle of entropy as the "root of nonlinear thermodynamics" (p. 140). Forces that perturb an organism prohibit its ability to function in a steady, linear fashion. Development is thus irreversible as it would be impossible for the organism to repeat the dynamics of its growth processes. The authors assert: "This change has to define our arrow of time. The increase of entropy for isolated systems has to express the aging of the system" (p. 258). In Evans (1970), Allport proposes that the growth of an open system "obeys the second law of thermodynamics" (p. 95). Kelley (1947) then applies this arrow of time to human development by noting that "we are purposive organisms" in that the human will take in from the environment only that which can be integrated into his/her "past experience and purposes" (p. 48). Therefore, from all that forces upon and perturbs the human organism, the human will seek out options that go beyond preservation to the enhancement of self. Finally, Combs et al. (1976) suggest that ". . . it is the organism itself which brings about the cure through its own return to effective organization" (p. 53). In sum, the human, along with other organisms, has an inherent capacity for self-healing through self-organization.

Combs et al. add that the human's capacity for self-enhancement is the result of the "tremendously complex brain and nervous system" (p. 71). One's development is largely related to how that person perceives the world and his/her place therein. The authors assert that a person's self-concept is based on how the self is perceived by the individual in all its complexity. Combs et al. state: "This organization is not a mere conglomeration of isolated concepts of self, but a patterned interrelationship or Gestalt of all self-perceptions" (p. 159).

Historian Heider (1973) notes that Ehrenfels, author of the original paper on Gestalt qualities, viewed the Gestalt process as mystical. In 1916 Ehrenfels published a book entitled, Kosmogonie, which suggests that: "A creative Gestalt principle confronts the formless chaos and imposes some order on it" (p. 69). Ehrenfels viewed the Gestalt as having a "chaos-kosmos" connotation. In seeking to avert the "then-prevalent atomistic theory of sensation elements" (p. 63), Ehrenfels insisted that the holistic product, or meaning, which is derived from a Gestalt experience can neither be segmented, nor explicitly defined. The Gestalt is the order that is both perceived and conceived out of the chaos.

According to Mahrer (1978), the Gestalt is the person's organization of bits and pieces that are perceived to arrive at personal meaning. Mahrer describes the Gestalt as a personal way of processing "intrusive stimuli" from the external world. Mahrer emphasizes: ". . . the way in which the person receives the very real intrusions from the real world depends upon the person, and not on the strength of the stimulus" (p. 190).

Humans are continually bombarded by fluctuations, or intrusions, which force changes upon the human organism. How that person reacts to the intrusions depends largely upon the Gestalt; that is, the way in which the perceptions are organized by the individual.

As Kelley, May, and other humanistic psychologists suggest, the human will strive for enhancement over the mere attainment of sustenance. The person will seek to grow and to develop, as opposed to remaining content with an existence that offers little more than life sustaining things (i.e., food, clothing, shelter). By virtue of this desire for fulfillment, it can be suggested that entropy--an irreversible tendency to move forward--characterizes human development, as opposed to tropism, the tendency to sustain life through the gratification of basic, "deficiency needs" (Maslow, 1962).

An additional, but important aspect of irreversibility has to do with the fact that the fluctuations can take an organism beyond a near-to-equilibrium state, to that of disorganization and chaos. Prigogine and Stengers note that even at this far-from-equilibrium state, "a coherence quite foreign to equilibrium" (p. 181) is introduced.

The manner by which a Gestalt can transcend from a perceptual field of random disorder to a perceptual meaning of coherence and order provides an illustration of Prigogine's thesis. The synthesis that is created by the perceiver brings the person to a higher state of consciousness in regard to the particular phenomenon.

Another illustration of Prigogine's thesis can be found in the context of developmental transformations. It is possible for an organism--the human--to be transformed into a new and differentiated order. Transformation, in this sense, implies a personality leap into a higher state of consciousness or development. This may include a conversion of the affect, a sudden insight of the intellect, or the like. In any case, the person undergoes a transformative change.

Maslow (1973) describes the transformation as a "total private and personal" (p. 384) revelation, conversion, or illumination which he refers to as a "peak experience." This is an "intrinsic core-experience" (p. 385) which places the person's consciousness into a new context. Transformations are moving processes in which irreversibility is implied. One might reach a plateau, or even digress, but it is scientifically impossible to return to a former state.

<u>Uncertainty/Unpredictability</u>

Despite the fact that life is entropical, or forward moving, there is always an element of uncertainty in the future. Kelley and Rasey express that much of one's uncertainty relates to that which is unconscious. These authors state that: "We like to think that, as adults, we are in charge of all decisions and are the captains of our fate" (p. 60). The fact is, however, that to a great extent, the human functions "in accordance with a powerful unconscious force" which brings a backlog of experience into the perceptual process.

May (1975) affirms Kelley and Rasey's contention that much of life remains uncertain because of the human subconscious. There exists within the human an uncertainty factor, for as one's potentialities remain dormant in the unconscious, one cannot know his/her possibilities for growth and creativity. May defines the subconscious/ unconscious as the source of experience; the mainspring for free creativity. Therefore, May states: "I define this unconscious as <u>the</u> potentialities for awareness or action which the individual cannot or will not actualize" (p. 55).

According to Goble (1970), Maslow's experiences with graduate students at Brandeis University led him to see that "freedom (permissiveness) could be growth-producing for some, but for others seem to produce negative results" (p. 62). Those students who appeared already healthy seemed to find freedom to be growth producing, others who were insecure found freedom debilitating. Maslow discovered, however, that ". . . as the individual develops, the need for control lessens, and actions become more natural and spontaneous" (p. 63).

Environmental conditions have much to do with one's personal dispositions. Allport (1961) defines personal dispositions as one's ideas and attitudes, interests and values, and modes or manners of expression. He adds that the dispositions are not identifiable as distinct units. Neither have they sharp contours or boundaries. Rather, the dispositions are indicators of a nuclear quality about the individual--his/her goal or meaning--and they "give shape or form" to the individual's personality. In essence, the personality is encompassed by one's dispositions.

Two major points about the dispositions can be made: 1) the dispositions stem from unknowns in the person's unconscious, and 2) one's behavior--the observable characteristic of one's dispositions--is not adequately reliable, or consistent, to be determined as predictable. Allport explains his position regarding the unpredictability of human behavior with the following illustration:

> A New York executive, almost always decisive, orderly, and prompt, may be reduced to virtual paralysis when confronted in a restaurant with a tray of French pastry. Why? Perhaps it is just fatigue at the end of the day; perhaps it is a buried complex traceable to punishment in boyhood for stealing tarts (p. 362).

Allport continues by stating that some psychologists assert "that personality has no inner consistency at all" (p. 362). However, Allport is of the belief that individuals may behave consistently for awhile, or in particular facets of their lives, but even here reliability is not complete. Allport offers the following conclusion: "Since the primary principle of behavior is its convergent flow, we cannot expect dispositions to be totally consistent and predictable" (p. 362). Furthermore, Allport holds that "the consistency of a disposition is a matter of degree" (p. 353) in which the clinician can often find contradiction.

In affirmation, Combs et al. (1976) point out that one's "perceptual field is potentially as infinite as the universe itself" (p. 407). This contention suggests an environment of randomness. The authors propose that the person exists not as a separate entity from that universe, but as "a dynamic part of the field" (p. 408), or the environment. In this way each person chooses to serve his/her own distinct purposes. Behavior is thus individual, and not highly predictable.

Whereas an outside observer might view one's choices as being ordered and predetermined by the circumstances of the environment (as if the person has no choice but to act a particular way), Combs et al. contend that behavior cannot be predicted because the person exercises free choice to facilitate his/her own self-actualization. Therefore, behavior is "totally determined by the dynamics of the field especially oriented about the phenomenal self and the need of the organism for self-actualization" (p. 408).

The question is then raised by Combs et al. as to why psychology must be approached in a deterministic manner.

These authors propose that humanistic psychology is based on the tenet that "the feelings, attitudes, hopes, and goals of the person--the personal meanings which are the underlying causes of behavior" (p. 411) are to be the focus of study, not precisely measurable behaviors. For Combs et al. (1976) assert: ". . . there is no exact one-to-one relationship between the meanings existing for a person in a given situation and a particular behavior that might follow" (p. 410). They add that "behavior is a symptom, not a cause."

Because personal meaning cannot be operationalized into behaviors, predictions based on generalized tendencies fail to consider the all-encompassing facets of the unique human. Thus, according to the humanistic paradigm, science need not--should not--be deterministic. Life is uncertain and unpredictable; in Kelley's (1951) words: ". . . life itself is a process, and will not become static under ordinary concrete circumstances" (p. 6). For this reason, Combs (1979) urges: "When dealing with the growth and development of human personalities, the reverse of the medical model is more often required" (p. 235). The time for an alternate way of viewing development is at hand!

Synthesis: A Nondirective Approach

Rogers (1969) supports the contention of Combs et al. that each person chooses from his/her own perceptual field those things that appear to be most enhancing. Nonetheless, a "quality of courage" is required in the choosing for in so doing, the person "step(s) into the uncertainty of the unknown" (p. 269). For all choices are risks, and the outcome of any choice is received by the risk-taker according to his/her personal meaning of the situation.

Due to the diverse needs and interests of people with seemingly common purposes and backgrounds, Rogers advocates the setting of meetings with no agendas. In this way discussions emerge from the participants who are thus free to explore possibilities for personal and group problem solving. Rogers (1977) refers to this as a "person-centered approach" in which: "the <u>process</u> is all-important, and the changes are only partially predictable" (p. 22).

Rogers opens the "encounter group" sessions with a statement that suggests how long the group will be together. He then informs the participants that they can use the meeting time however they wish. Rogers than listens with acceptance, "to whatever is expressed". He adds: "I dislike using any procedure that is planned" (p. 23).

Though words such as nonlinearity and randomness are not used, Rogers alludes to these assumptions with the manner by which he allows the encounter group meetings to emerge from the spontaneity of personal meanings and dispositions. In essence, Rogers accounts for the anomalies of human development.

Moreover, Rogers rejects the attempt to predict that anything predetermined should come from such meetings. In seeking to establish a sense of community among the participants, Rogers notes the importance of looking for approximations that might point toward new possibilities for a brighter future. Rogers suggests:

> The discovery of anything that is approximately true has an earthshaking revolutionary power. And I believe we are making some such discovery, though I can't define it, and can only observe some of its characteristics (p. 149).

In regard to the assumption of irreversibility, Rogers (1977) supports the contention of Kelley, Maslow, May, Combs and others, that development is directional and self-motivating. Rogers agrees, therefore, that the "organism is self-controlled" with a "directional tendency toward wholeness, toward actualization of potentialities" (p. 240). And, like the natural scientists who explores uncharted territories, the "tendency for growth and the direction of growth" takes one on toward higher complexities. Rogers states: "Life flows into ever more diverse forms, correcting its errors, and moving toward its own enhancement" (p. 244).

Humans do not undo development and return back to former states. This holds true even when individuals show conscious rifts or perversions in the "natural directions of the unitary actualizing tendency" (p. 247). It is thus concluded that there is no logical path to understanding. Only intuition and a "sympathetic understanding of experience" (p. 273) can bring the scientist closer to the nature of development.

Rogers' contention leads to the following implications: Life is uncertain. The human is confronted daily by random occurrences from the environment. These external conditions initiate behaviors which stem from uncertain (unconscious) feelings, attitudes, and the like. Because humans differ in their responses to particular situations, it is suggested that behaviors do not follow straight paths; instead, humans take nonlinear courses to arrive at their hoped-for destinations. There is, however, a directionality to becoming developed (e.g., self-actualized, fully functioning), and that aspect of development implies irreversibility. Although one may encounter setbacks, or emotional rifts, in his/her development, it is impossible to return to a former developmental state.

In conclusion, the humanistic paradigm appears to be an application of discoveries about the nature of the universe, as made by physicists, mathematicians, chemists, and other proponents of the new science to the nature of the developing human. In accordance with the Chaos scientists, the humanistic psychologists suggest that development is random, nonlinear, irreversible, and uncertain. For these reasons, the course of one's development cannot be predicted.

Development encompasses a vast array of anomalies which must be considered if the human is to be even partially understood. The humanistic paradigm bridges the gap between the new science's discoveries of inanimate transformative processes and the transformations of human development.

CHAPTER V

A SYNTHESIS

The nature of human development has been an ongoing issue throughout the ages. Just as Newton determined that objects and events of the universe operate in standard and predictable ways, the social sciences have adopted a mechanistic rationale for defining the human by using terms of measurement and prediction. Education has thus come to specify behaviors that can provide for the accommodation of the human (the child) to the organizational structure (the grade level) of the school. Developmental theorists have come to be heralded as the support for making such determinations.

This study explored the validity of Newton's rationale in light of more recent discoveries in new science. It has been found that scientists from among the different fields have discovered that the universe cannot be predetermined, nor is it ordered and linear. In fact, as a result of Einstein's theory of relativity and the subsequent emergence of quantum mechanics, along with the more recent discoveries of the Chaos scientists, a new paradigm is emerging which promulgates the universe as a flux of random, nonlinear, irreversible, and uncertain processes. For these reasons, the outcomes of nature's phenomena are unpredictable and can only be estimated by approximation. Whereas Einstein asserted that God does not place dice; today, proponents of the new science are suggesting that God plays pinball (Pagels, 1982).

Nonetheless, it is argued by Schopen (1989) and Lucas (1985) that many members of the natural and social sciences are continuing to view the human in accordance with Newton's deterministic principles. Across the nation state departments of education (e.g., Pennsylvania, Connecticut, Oregon) are calling for a tightening of policies that will assist in decisions regarding grade placements/retentions. Some states and districts (e.g., Georgia; Austin, Texas) are enforcing the use of measurement instruments as the basis for making determinations about a child's school placement. In such cases a child's test score is used to predict his/her performance potential for a particular grade level. Failure to meet the scoring criteria predetermines the child's being placed at a lower grade level.

The researcher of this study has looked to three leading developmental theorists whose works have impacted educational decisions and practice in the United States. Bjorklund's (1986) survey of research on developmental placement includes references to the Gesell theorists. Piaget's theory of cognitive psychology has become the dominant theory on development today (Brennan, 1982). And Montessori preschools have been established nationwide to facilitate the readiness of preschoolers for meeting the grade-level expectations that have become standard throughout the public/private schools (Goodlad et al., 1973). Because educational policies and practices are often linked to one or more of these developmentalists, the respective theories of Arnold Gesell, Jean Piaget, and Maria Montessori have been explored.

A primary goal for this study has been to see if there is a different way that the knowledge base of human development can be critiqued. In researching the new science, from the findings of Einstein and Heisenberg (that the universe is relative and uncertain) to the more recent findings of the Chaos scientists (that systems and organisms change through processes of transformation), it has been found that there is not a linear and reversible--mechanical--order to nature as was once postulated by Newton and Descartes. For this reason, phenomena such as the weather cannot be predicted with certainty (Gleick, 1987). Neither can the human's development be predicted in a deterministic way.

Upon studying Gesell, Piaget, and Montessori it was discovered that each was a scientist in his/her own right: Piaget was a biologist, Gesell and Montessori were medical doctors. As scientists, it was presumed that each would have his/her own philosophy of science, and that this philosophy would be incorporated into each scientist's theory of development. In the course of pursuing this research, it was discovered that Gesell's phylogenetic emphasis of development was strongly influenced by Darwin's theory of evolution and G. Stanley Hall's recapitulation theory (Gesell, 1968). On the other hand, the ontological philosophy of Piaget and Montessori, that development occurs both through evolution and one's construction of knowledge, can be gleaned from the biographies of these two theorists (Lillard, 1972; Piaget, 1968). In sum, it was found that the developmental theories of these three individuals parallel their respective philosophies of science.

It was further discovered that the developmental theories espoused by Gesell, Piaget, and Montessori do not tend to be in accordance with the assumptions of randomness, nonlinearity, irreversibility, and uncertainty as now proposed by new science. Instead, these theorists tend to suggest that the natural processes of development encompass: invariance and order as opposed to randomness, linearity as opposed to nonlinearity, and predictability as opposed to unpredictability and uncertainty.

Piaget (1928) emphasizes reversibility in regard to thoughts. The goal is to go from transductive (ego-centric) reasoning to that which is inductive-deductive. Specifically, Piaget defines development as cognitive growth. Because one's cognition is more fully developed when the person can reverse his/her thoughts, Piaget holds that one has progressed in development when one understands the back and forth nature of operations (e.g., 2+2=4, 4-2=2), and can conceive of things from the other's point of view (e.g., sharing with Sue will cause Sue to want to share with me). Piaget adds: "The essence of thought is the attempt to make reality itself reversible" (p. 18). In general the philosophies of these developmentalists conflict with the nondeterministic assumptions of new science.

Development: A Classical Perspective

In this section, some ways in which Gesell, Piaget and Montessori cling to a Newtonian world view are highlighted. The respective theories of these developmentalists will be integrated for a discussion of the following issues: stage development, the learning process, the curriculum, affective development, patterns and predictions, diagnosis, and grade placement/retention. Not all of these topics are addressed by each of the theorists, therefore, the topics are discussed only as they have appeared in the literature.

Stage Development

Each of the developmentalists proposes that development progresses through stages. According to all three, the stages are sequential and invariant, thus every child must pass through each stage in the order proposed as the route to adulthood. Invariance refers to the fact that there are no other paths to development, and no stages can be skipped along the way. According to these theorists there are no exceptions to the laws of stage development!

Gesell and Ilg (1946) refer to the stages as growth gradients and present the life cycle as a series of "maturity traits" encompassing seventeen age levels in ten major fields of behavior. Ilg et al. (1981) note that the progression through the stages does force the child to confront fluctuations, or periods of disequilibrium. However, these are not "random" occurrences. They come upon the child "in a lawful and patterned way" (p. 7).

Montessori's (1967) stages are referred to as sensitive periods which are necessary for both growth and "psychic development" (p. 96). The reference to "psychic" development is in regard to the child's intellectual functioning. According to Montessori, certain learnings are more easily undertaken in particular stages, or sensitive periods, than in others. Thus an infant in the first sensitive period finds the learning of language to be less troublesome than does an older person trying to learn a second language.

An interesting aspect of Montessori's (1967) theory is that she criticizes Darwin for having put forth such a "linear" description of evolution (which Montessori views as nonlinear). Her reference is to the fact that the organism is a dynamic system always in flux with the world. Its agents have unique tasks to fulfill. As the heart performs one function, the lungs do another. Viewing the organism from an ecological perspective, Montessori holds that the trajectories from all of these parts would indicate a nonlinear flowing of trajectories to an end of one's life.

Because of the inherent dynamics that comprise the organism, the path to development must be nonlinear.

Nonetheless, Montessori postulates the stages as ordered and invariant sensitive periods. Other aspects of her theory lean toward linearity: 1) she singularly focuses on cognitive growth to the neglect of the affect, and 2) the manner by which the learning tasks must be approached is sequential and ordered. It is, therefore, difficult to classify Montessori as a proponent of nonlinearity despite her claim to be so.

Piaget (1981b) specifically describes his stages as "constant and sequential" (p. 205) in the order by which they are met. He continues that while children may differ in their rates of passing through the stages, and to the degree that their development might lead them, there is no escaping the fact that all growth is ordered, sequential, and invariant.

The Learning Process

Gesell (1945) holds that intelligence is innate; the ground plan of which is laid down by the genes. Gesell and Ilg (1946) hold that intelligence is a function of growth, and the tissues of the mind develop in the same way as the tissues of other organs. Furthermore, the development of thought is lawfully patterned. In sum, the Gesellian theory finds learning to lie within the organism; it cannot be externally controlled. As a result, Ames et al. (1972)

assert that there is no point in trying to teach a child before he/she is maturationally ready to receive the teaching.

In contrast, Piaget (1981a) contends that intelligence is neither innate, nor is it hereditary. Learning is constructed. Piaget (1977) describes the learning process as the construction of knowledge. In the process, the child cognitively acts upon objects and events in the world with "continuous and laborious effort" (p. 31). In describing Piaget's theory, Furth (1981) notes that this construction is an active, not passive, internal process.

Piaget's (1981c) equilibration theory describes how the construction of knowledge occurs through: 1) physical knowledge, 2) innate or hereditary factors, and 3) social knowledge. He holds that the innate/hereditary factors merely govern the regulatory functions of the self, and the social knowledge is a processing of social relations in the same manner by which physical knowledge is processed. (The emphasis then is not on how one feels about social relationships, but on how they are processed/understood.) The construction of physical knowledge is, therefore, the crux of Piaget's theory.

Piaget (1981a) notes that for the very young, physical knowledge rests with sensory-motor actions upon objects or things in the world. As one develops, however, the cognitive processes of adaptation (i.e., assimilation and accommodation) and organization are used by the individual first through concrete operations, and then in abstract reasoning. It is at the level of abstract reasoning that the operations are internally combined into structures. The importance of physical knowledge is, however, that all learning must start here; for every abstraction there is a material or physical root. Hence, one cannot get to the level of abstract reasoning without first passing through the cognitive processing of physical (sensory-motor, preoperational) and concrete operational experiences.

In sum, Piaget's (1981c) equilibration theory suggests that all learning encompasses: 1) physical knowledge, 2) heredity, and 3) social knowledge. Whereas both physical and social knowledge are dependent upon the functions of the intellect, the hereditary factor is not. Heredity is not an important part of learning, according to Piaget, because it does not satisfy our yearning for a logical understanding of the world (i.e., logical necessity).

Montessori (1967) shares a comparable learning theory to that of Piaget, asserting that the child "bears within him constructive possibilities" (p. 57), but Montessori does not attempt to explain the cognitive processes. She emphasizes that learning is purposeful interaction with the environment in the same way that building a structure with stones or bricks is purposeful and unique construction. Just as buildings differ in their shape and ornamentation, children differ in what and how they learn. The process is dependent upon the goal (purpose) and the implementation (choices and actions) of the builder. Though there is an inherent "natural unfolding" in the course of development, the child's learning is also characterized by "spontaneous manifestations."

The Curriculum

The Gesell theorists do not concern themselves with the curriculum per se, only that the child be held back until maturity provides him/her the capacities for handling whatever might be expected of children at the differing grade levels (Ames et al., 1972; Ames, 1967). Piaget, similarly, has little to say about how a child should be educated.

The proponents of Piaget, and Montessori herself, have much to say about such things as the way a child should be taught (i.e., the methods and materials), and the learning environment or climate (i.e., the noise level, amount of freedom, etc.). The following sections deal with these aspects of the curriculum.

<u>Methods and Materials</u>. According to Kamii and DeClark (1985) a Piagetian classroom does not impart learning through social transmission. Instead, children learn by being actively engaged in learning tasks. These authors suggest that the curriculum focus on activities that can model situations in daily living with the use of games. All mathematics texts, for example, should be done away with in the primary grades for the use of games and projects that force the children to problem-solve through action, as

opposed to passive abstraction on paper and pencil tasks. Furth (1970) affirms this contention noting that social activities develop the intellect. He recommends field trips and role play.

Montessori began her work with materials she specially created for mentally retarded children. Her first school was initiated to see if the materials would be successful with normal children (Lillard, 1972). Throughout her career, Montessori developed materials that would enhance children's learning. Montessori (1956) emphasizes the orderliness of the tasks, that they are to be approached in the manner by which they were intended. Montessori Jr. (1976) adds that his mother planned the materials with "built-in controls" (p. 69) to insure that the child would have automatic feedback regarding the correctness of his/her procedures with the tasks.

In sum, both the Piagetian and the Montessorian classrooms find children actively engaged in the learning. In both cases the tasks are designed more for instructional gain than for social growth (Furth, 1970). Montessori, in fact, prefers the children of her classrooms to work in isolation, being totally free of distractions so that they might become absorbed in the learning (Montessori, 1967, 1966, 1956).

<u>Climate/Environment</u>. It can be surmised that the environments of both classrooms (i.e., the Piagetian and the Montessorian) find children pleasantly about the business of

learning. The proponents of both curricula describe the classrooms as such. One reason for the pleasantness is because an inherent aspect of these programs encompasses self-direction. The child may freely select from the array of activities what he/she chooses to do. There are parameters, regarding the self-selection, for the tasks are designed to facilitate cognitive-intellectual skills. The Piagetian curriculum seeks to advance operational thought, the Montessori curriculum seeks to advance academic skills (e.g., reading, mathematics).

Proponents of Piaget (Kamii and DeVries, 1980) assert that children do not distinguish between work and play. Montessori (1956) insists that if the materials are used incorrectly, in that the children are socializing with them as opposed to staying on task, then the teacher must intervene and break up the disorder. Whereas the Piagetian classroom may be filled with talk, movement, and noise, Montessori's classroom finds children engaged in activities and movement, but with minimal talk or noise. In this way Montessori counters Kamii and DeVries' contention with the assertion that children do distinguish between work and play! Only work is appropriate for the classroom, and children are happiest when they are working (Montessori, 1949).

Another point of contention between the Piagetian and Montessorian classrooms rests with the fact that the Piagetian theory holds that children should not be taught certain concepts until they have reached a stage of understanding

(Piaget, 1976). Mario (Montessori Jr., 1976) asserts that the use of his mother's curriculum worldwide has repeatedly shown that very young children can be taught reading and mathematics when absorbed in the learning. The teacher should take advantage of the child's high interest rather than holding back until he/she becomes ready.

In sum, the Piagetian curriculum allows for talk and movement as the children work together on the learning games/activities. Because the goal is for discovery, little explanation is offered by the teacher. The Montessorian teacher, on the other hand, demonstrates the tasks offering instruction, at least, in the initial phase of learning. Even then, talk is to be kept at a minimum because children can derive more from the visual/tactile than the auditory mode of learning. In both curricula, the children are free to select from that which is laid out in the classroom.

Affective Development

None of the developmental theorists put much emphasis on affective development. Piaget in the Bringuier (1980) interview states pointedly that he has no interest in that area of development. It is for this reason that the Piagetian curriculum focuses on activities that promote intellectual growth. Furth (1970) makes this point very clear even though he promotes excursions outside of the school, simulation games, role play, and the like. The entire focus is for cognitive (intellectual, operational) growth. The active social experiences are thus for the purpose of attaining knowledge. The aspect of finding meaningful social relationships for the development of affect is not addressed. It is not what the child feels that matters, it is what he/she knows.

Montessori concerns herself with the social aspect of development even less that Piaget and his constituents. School is for learning; therefore, work is good, but "aimless wanderings" of the mind (e.g., fantasizing, play) are evil (Montessori, 1966; 1956).

Proponents of the Gesell Institute concern themselves so much with the child's academic performance that any affective concerns relating to grade retention are minimized. Ames et al. (1972) oppose social promotion on the grounds that placing the child's emotional needs over his/her need for academic success is more damaging than tending to the real issue, his/her academic success. Ilg et al. (1981) affirm, noting that fears over the harmful effects of grade retention are "largely groundless" (p. 240).

It can be surmised that each of the developmentalists prioritize the growth of knowledge--intellectual, academic learning--over all other aspects of development. In this way developmental theory is narrowly focused on linear. In accordance with normal science, a set of criteria concerning intellectual growth is abstracted from the child so that his/her development can be defined in measurable and predictable terms. Whereas the humanistic psychologists hold that the facets of development are integrally woven and, therefore, must not be dissected for analysis, the developmentalists rely upon the scientific method to guide their determinations about the nature of development.

Patterns and Predictions

Each of the developmental theorists predicts that humans develop according the patterns of his/her respective stage theories (e.g., growth gradients, sensitive periods). Piaget holds that a child cannot be taught operations until the child has reached the stage of operational thinking; Montessori contends that a child can be taught to reason linguistically or mathematically as long as the child is highly absorbed, or concentrated, with keen interest. It happens, however, that the keen interest is likely to correspond to a sensitive period in which the learning of a particular task comes more naturally for the child. In these ways Piaget and Montessori use patterns and predictions to determine the course of development.

The researchers of the Gesell Institute have much more to say about patterns and predictions. Ames (1967) notes that girls mature faster than boys. Ames et al. (1972) affirm stating that of the children who use the Institute for remedial purposes, the gender ratio is 5:1 in favor of the boys. The major point, then, is that the gender problem is predictable.

Ilg et al. (1981) discuss the swings in development from disequilibrium to equilibrium which correspond to particular levels of development as specified on the growth gradients charts. In sum, it can be predicted when the child will hit the "terrible twos" or any other difficult stage of development.

Finally, all the researchers of the Gesell Institute propose that a child's success in school can be predicted. Ames et al. (1972) declare that early tests are predictive, and the Gesell Institute is acclaimed for its readiness test used by districts nationwide.

Diagnosis

Only Gesell and his proponents address the subject of diagnosis directly. The Piagetian tests were instruments used for research purposes. DeVries (1978) criticizes the use of Piaget's tests for placement or instructional purposes. And Montessori's diagnosis was conducted informally through observation of a child's performance on a task; thus, it was not diagnosis, but teaching!

Ames (1967), on the other hand, recommends the use of tests to determine a child's readiness for schooling. She adds that intelligence testing should be a part of the diagnosis, though not the main emphasis. It matters, therefore, what the child innately brings into the learning. In accordance with the Gesell's phylogenetic emphasis, the hereditary factor of intelligence will bear upon the child's development.

Ilg et al. (1981) caution that the intelligence test not deter the diagnostician from considering the rest of the web, the intelligence aspect is only one factor. Nonetheless, "individual behaviors develop predictably" (p. vii). The focal point, therefore, is to use whatever information that might be available for painting a diagnostic picture of the child. The portrait can then be mirrored against the growth gradients for predicting the child's future in school.

<u>Grade Placement and Retention</u>

In sum, it is only Gesell and his proponents who address the issue of holding a child back a year until he/she becomes ready, or retaining a child in the same grade for another year. Ames (1967) asserts that in the schools of today there is a "tremendous amount of overplacement" (p. 5). She adds that nearly all children who are brought to the Institute seek out the remedial help because they have been overplaced.

The reader is reminded that recent reviews of the literature find the research data to be inconclusive on whether or not grade placement, or retention, is a viable option in terms of contributing to children's overall development

(Bjorklund, 1986). It is for this reason that state departments suggest that districts offer options in establishing promotion/retention policies (Pennsylvania, 1985; Connecticut, 1984; Oregon, 1985). Because the data are inconclusive, placement/retention is a controversial issue; agreement cannot be reached.

Even though Piaget and Montessori do not address the issue of school placement, it can be seen that all three of the developmentalists lean toward the Newtonian (classical) theory that nature is ordered, linear, reversible, and predictable. In a nutshell it will be shown how the developmentalists view the nature of development from a classical lens: 1) The stage theories in general (i.e., the growth gradients, sensitive periods, and even Piaget's equilibration theory which encompasses the construction of physical and social knowledge as well as the hereditary factors) suggest that development is <u>ordered</u> and not random. There is a definite pattern to the way in which development occurs, and these theorists postulate that the pattern is invariant, thus no anomaly, or exception to the rule, can be found. Montessori furthers the conception of order in that she requires that order be maintained in the external learning environment because the route to learning (constructing knowledge) is an internally ordered process. 2) Similarly, <u>linearity</u> is a factor of the developmental theory, not only in regard to the stages (which are sequential as well as ordered and invariant), but also in the sense that all of these theorists view development according to the narrow line of cognitive, or intellectual, advancement. For Piaget and Montessori this is obvious. Gesell philosophically ties the intellect up into a package with the entire being, as phylogenetic theorists do, but the Gesell Institute proponents place academic success over all other aspects of development to the neglect of affect. 3) Reversibility is mentioned only by Piaget who suggests that the progression from ego-centric thought (transductive reasoning) to decentering (developing social reciprocity) requires a reversibility in one's thinking process, being able to think through operations and social events from their diametric positions. For example, the conservation of Piagetian tasks requires that a child be able to reverse operations. Key to the theory is the construction of logical thought, and this comes about only by developing to the stage of concrete, and then formal, operations when the child becomes able to decenter and reverse his/her thoughts. And 4) the assumption of predictability is implicit in all of the stage theories suggesting how the human is destined to develop. This assumption is paramount to the diagnostic/prescriptive philosophy of the Gesell Institute.

From the above it can be concluded that the dominant thought on developmental theory draws from the same assumptions that new science has now abandoned. The following section presents a discussion of development in accordance with the assumptions that found the emergent paradigm of Chaos.

Development: Transformational Theory

In contrast to dominant theories of development as postulated by the above theorists, Chapter IV presented development as being nondeterministic. The preceding chapter (Chapter III) introduced twentieth century scientists who paved the way for transformational theory with discoveries that the universe is comprised of randomness and nonlinearity, irreversibility and uncertainty. The paradigm is now promulgated by chemists, physicists and mathematicians, astronomers, and biologists. Taken together, these scientists support the contentions made by the humanistic psychologists of the 1960s and 70s that development occurs through a series of transformations which are neither linear, nor predictable because development is fully-encompassing, not restricted to only cognitive growth. Chapters III and IV suggest that development takes into account every minute fluctuation that might set any one of a multitude of responses (feelings/sensations) into motion, or en route to a bifurcation. This is not to suggest that a flux would necessarily even create a perturbation in the organism, and that fact of uncertainty is what makes development unpredictable! But once the organism has chosen to respond with a primary, or initial, bifurcation, the occurrence of this shift paves the way for other such bifurcations until the organism (person) has undergone a major transformation in his/her life. This, in a nutshell, is the transformational theory. The following sections explore the theory according to its basic assumptions.

Randomness

Rogers (1973) describes evolution as a "fluid valuing process" (p. 201) in that intervening variables--fluxes--continually affect one's choices, and thus, the course of his/her development. Development is compounded by "irreconcilable choices" (p. 274). Kelley and Rasey (1952) add that the organism is in perpetual flux as it lives in "a milieu of movement" (p. 20). Combs et al. (1976) note the "practically infinite" perceptions that a person will experience at a given moment. People do not respond in the same way to a shared experience, according to Snygg and Combs (1949), because of the inherent differences among them. Therefore: ". . . the behavior of the living organism is erratic, irregular, and relatively unpredictable" (p. 341).

Nonlinearity

Allport, in Evans (1970), asserts that there is no cause-effect connection between events and one's response. Also, nothing can be predetermined about what a child will value despite his/her parents' teachings. This nonlinear relationship between the input of parenting and the output of behavior supports the contention that life is both random and nonlinear; there are too many intervening variables.

Combs (1982) refers to the openness of the organism as the human in flux with things of the world. Because of this openness, the human is: 1) more open to experiences, 2) able to identify with others, 3) more knowledgeable, and 4) able to view the self in more than one way. Through each of these, the human is able to develop a more positive sense of self.

Humanistic psychologists do not dissect the human into categories of cognitive, affective, and psycho-motor domains. Instead, these aspects of the human are seen as integral processes that are continually in flux, or movement, in the organism on nonlinear trajectories. The human is all of these at once. Thus May (1969) notes the integration of the cognitive with the affective processes as he states: ". . . we cannot know except as we feel" (p. 303). Additionally, May (1975) asserts that humans combine passion with their need for organization (which he refers to as form), to arrive at a "wholistic scene" for understanding the world.

Irreversibility

May (1973) proposes that the human cannot last in the condition of maintenance for very long. Humans have a need to grow toward something and not stagnate. Combs et al. (1976) add that humans seek self-organization when changes are imposed. One looks for coherence out of the conglomeration of random, isolated, bits of information; thus, one seeks the Gestalt!

Heider (1973) notes that Ehrenfels created the concept of the Gestalt in 1916 with the idea that humans have a need to make sense out of the "formless chaos" (p. 69). Rather than to be confused by the atomistic sensations, humans seek a holistic meaning that will bring the chaos to a higher order.

This notion of order out of chaos leads back to the importance of entropy. Entropy surpasses the life-sustaining connotation of tropism in that entropy, being messy, seeks a rejuvenation to a higher order. The concept implies a desire to create something new out of that which exists.

In viewing development from the lens of transformational theory, as opposed to that of the classical theorists, the human seeks not merely to construct knowledge--to learn--and grow cognitively; instead, it is enhancement and fulfillment toward which the human aims. It is a higher consciousness, peak experiences, the actualization of one's potentials--all that transforms the human into a new and differentiated being, all that takes the person from chaos and turmoil to a higher place of inner peace and serenity--that is sought by the developing human. Maslow (1973) describes the transformation as a "total private and personal" revelation which places his/her consciousness into a new context.

Though Prigogine and Stengers (1984) do not make a direct application of transformational theory to the human, they state: "On the human level irreversibility is a more fundamental concept, which is for us inseparable from the meaning of our existence" (p. 298). It is further noted by Prigogine and Stengers that irreversibility ". . . is the mechanism that brings order out of chaos" (p. 292).

Uncertainty/Unpredictability

Rogers (1966) contends that collecting data is a futile means of determining how a person will perform in the future. It is impossible to "postdict" because data can never be instantaneously collected from all of the facets that pertain to a human's behavior. There is too much changing in the flux!

Much of life remains uncertain because of the human's ability to choose. Underneath all those choices lie unconscious forces which remain unknown, yet they add to the complexity of one's behavior and choices (Kelley & Rasey, 1952). May (1975) proposes that for the human, the dimension of unconsciousness is the root of the uncertainty factor.

In discussing Maslow's teachings, Goble (1970) notes that the healthier humans become less perturbed by their unconscious. Allport (1961) argues that one's dispositions are behaviors which stem from the unconscious, and these are completely unpredictable. He uses the illustration of a New

York executive falling totally out of his typical nature, being "reduced to virtual paralysis," when confronted with a tray of French pastry in a restaurant. The point is that it can never be predicted how a person might respond to even the most insignificant of perceptual stimuli. As a result, Allport concludes that while there may be consistency on the surface, the unconscious prevents human behavior--dispositions--from ever becoming reliable. Human nature, therefore, remains uncertain and, thereby unpredictable.

Conclusion

Kelley and Rasey (1952) discuss the processes of organic development in a way that bridges the gap between transformational theory with inanimate objects that bifurcate as a result of "sensitive dependence on initial conditions" (Gleick, 1987), and the human organisms that bifurcate as a result of choice. This is an important issue which, ultimately, distinguishes the difference between Darwin's theory of evolution and the new biology as postulated by Augros and Stancui, and Stephen J. Gould.

According to Kelley and Rasey, all systems (organic and inorganic) expend energy. Nonliving matter spends its energy by withering away; that is, a rock erodes. Organisms, on the other hand, spend energy for self-preservation. Thus the plant chooses to turn to the sun (tropism), whereas the rock's erosion is beyond its control.

Choice is an inherent part of transformational theory. Humans have a degree of control over how their energy will be spent in that they can choose. Kelley and Rasey also state that the nonliving (inorganic) matter transforms from order to disorder; the rock may wither away into dust, a disconglomeration of particles. The living (organic) being, however, transforms from disorder (chaos) to order.

Because of the human's capacity for choice, the transformational theory assumes that the choice is always for a higher order; the organismic system transforms from disorder to order by choice. According to the law of entropy (irreversibility), change is always bringing "order out of chaos" (Prigogine and Stengers, p. 292). And once the transformation has taken place, the organism cannot return to a former state.

It might be argued that humans do digress in their development; that they lose ground and forget what had previously been learned. In transformational theory, however, the act of forgetting would be comparable to a system encountering another flux which throws the trajectory off course. When one forgets, he/she digresses (i.e., roams or wanders off course), the person does not regress (i.e., return to the past). It is impossible to break the entropy barrier and relive the past.

It should also be noted that a bifurcation is not, in and of itself, a transformation. Therefore, when one forgets prior learning and his/her trajectory is thrown off course, the bifurcation means that a new course has emerged. Transformational theory holds that a person will continually be in flux with changing circumstances and conditions. It is because of these random occurrences that one is continually making choices.

Whitehead's (1934) philosophy suggests that as the organism responds to the random fluxes of the world (and this can include the occurrence of forgetting something), the person will simultaneously probe into the past (triggered by unconscious associations), and into the future (anticipating possibilities), and simultaneously integrate these processes to make a choice for the present. Using these processes, then, the human makes a choice. It remains uncertain, however, as to whether this bifurcation will be manifested into a transformation.

Finally, Kelley and Rasey (1952) assert that the living matter, the organism, has an innate need for others. The infant is born with a dependency upon its mother, the plant and animal have a mutual dependency upon each other in terms of how they use the air, and the human and animal have a dependency upon each other, as do all the entities of our ecological world. Therefore, Kelley and Rasey assert: "Man, then, is a social creature or he is nothing" (p. 30).

From Kelley and Rasey's discussion it can be seen that the living organism, unlike the inorganic, has a choice in its development. Moreover, the human chooses in accordance with what one believes will lead to the reaching of a higher order, a transformation. As one develops, setbacks are encountered. But these do not return the human to a less developed state. The setbacks (fluctuations) are merely digressions that force the human to select alternate paths. These, too, may lead one to a transformation, for the path therein remains uncertain.

The key point of the theory is that the person does not seek transformation from a vacuum. Humans are social creatures and cooperation is vital to survival. This brings the discussion to the new biology and its opposition to Darwinism.

Changes do not occur in the organism through slow and successive accommodations to "favourable variations" as Darwin (1936) postulates. Neither do they occur through competition. Augros and Stancui (1988) emphasize the cooperative nature of the inhabitants of the earth. Furthermore, Gould (1977) affirms these authors that evolution is not slow and successive, but spontaneous and sudden. Darwin's theory has simply not held out against the findings of modern science and the fossil record.

Humans do not succumb to a state of preservation (health) by making slow adaptations to the fluxes of life. The fact that a mutant may emerge, changing a species every several thousand years or so, says nothing about the development of a human being. Darwin asserts that ". . . natural selection acts only by taking advantage of slight successive variations; but she can never take a great and sudden lead

. . ." (p. 144). May (1975) describes the transformation that occurred in his own life as an event which came upon him suddenly as a burst of insight that changed his entire philosophy of life and human development. This sudden insight came upon May unexpectedly and was irreversibly life-changing.

Although the transformation impacted May in a sudden and unexpected way, many years of choice-making (in May's case, studying) led to its emergence. The human has the capacity for choice and can, thereby, have a part in the creation of his/her own destiny. At the same time, however, it is futile to think that the human has control in the course of his/her development. The importance of choice, however, is that it implies opportunity. And it is only opportunity that one can be guaranteed. One cannot presume that certain events will take place. One can, however, continue choosing, through approximation, paths that might bring one closer to higher planes of actualization, or fulfillment, that is intrinsically sought.

Whitehead (1925) acknowledges that the organism changes over a "lapse of time." According to Whitehead, there is a reciprocity between the parts and the whole of the organism. The whole is affected by the modifications that are made by the body parts. These parts are peculiarly sensitive and, therefore, easily thrown into instability. But because the organism has an "emergent enduring" pattern that seeks growth toward higher states of wholeness, the fluxes of the world serve to help the organism individualize itself. But Whitehead (1932) adds: ". . . no event can be wholly and solely the cause of another event" (p.41).

The child is a whole being comprised of an infinite number of dynamic parts. As Whitehead suggests, these parts are peculiarly sensitive and a fluctuation touching any small part of the child's life can throw his/her entire being into instability, even chaos. To complicate the matter even further, the dynamics that play among these various perceptual/unconscious parts of the child can be so intricately woven that a concerned caretaker (e.g., parent, teacher) may have difficulty knowing what is really wrong. Whitehead continues that the causes among events cannot really be known. Thus even the child cannot understand where the turmoil comes from, and how things might be made better.

The transformational theory suggests two implications, one in the form of a caution; the other, an offering of hope. In closing, this study leaves these thoughts for consideration:

The first implication, the caution, goes out to policymakers and adults who impose conditions on children without knowing what impact the child will receive from the decision. It should be remembered that large-scale decisions often appear as viable solutions to problems until such decisions are brought home, or translated as a determination of a particular child's future. There often seems to be a discrepancy between what is deemed as worthwhile for the masses in comparison to what is believed to be the best for a single child.

The second implication, the offering of <u>hope</u>, can be extended to one and all. For though transformational theory provides no controls that guarantee a desired future, the human is promised a lifetime of opportunities to choose. While the fluxes of life may be random, the choices are intentional. Although the human can never lay claim to a predictable tomorrow, through approximations, one can sense possibilities for attaining desired goals. Therefore, courses can be charted, one foot can be placed before the other. When fluctuations, or intervening variables (as the humanistic theorists would say), alter one's perceptions/ feelings, etc., and ability to proceed on with the original plan, other options become available.

This attribute of choice is no way to suggest that the fluxes, or the recovery processes, are painless. Instability, chaos--pain--is an inherent aspect of transformational theory, and an unavoidable part of life. The hope rests with the fact that: 1) the pain is not forever because 2) humans are entropic beings, always striving to attain a higher order.

Finally, transformation is available to all. It cannot be predicted as to when or how it might appear. Nor can it be known how many transformations a person might encounter in a lifetime. Rollo May and Poincare both experienced their significant transformations after they were grown (May, 1975). But because humans are entropic beings, continually striving for enhancement and actualization (Maslow, 1973), transformations are impending!

Recommendations

This study addressed the state of the field in regard to policies and decisions that affect children's placement in school. It was determined by Bjorklund (1986), Pain (1981), and the Pennsylvania (1985) state department handbook on promotion/retention policies that the literature is inconclusive on whether such decisions are developmentally sound. Developmental theory was researched from two perspectives: 1) that of classical science from the viewpoints of Gesell, Piaget, and Montessori, and 2) that of transformational theory from the viewpoints of the emergent Chaos paradigm, and humanistic psychology. It was discovered that transformational theory can offer no more information regarding the placement/retention question than can the classical paradigm which has dominated education for the past two centuries.

Although new light could not be shed on the placement issue, the study has provided greater insight into the processes of transformation which encompass human development. It was particularly noted that development entails many unknowns; moreover, it was discovered that development is a lifelong process. All facets of one's perceptual, emotional and constructive realities are integrated into one's past and anticipated future as the human chooses for the present (Whitehead, 1925). Additionally, the only certainty that exists for the human is his/her capacity to choose, and the opportunity to make new choices when previous choices have led to chaos.

These findings appear theoretically sound and in accordance with the discoveries of new science. Further research in the form of case studies would offer greater insight into the bifurcation processes, and how they emerge in people's lives. Rollo May (1975) has offered a detailed account of not only his own transformation, but also that of Henri Poincaré. These examples helped the researcher to understand better how bifurcations such as unexpected bursts of heightened consciousness, sudden insights, and the like are irreversible and significant parts of one's growth and development.

Theoretically, processes of randomness and nonlinearity are ongoing occurrences in a person's life which lead to transformations. It is recommended that the social sciences embark on case studies with humans of all ages to arrive at a better understanding of the human and his/her needs for healthy development. Perhaps through the reporting of such studies in the literature more care might be taken in regard to establishing large-scale policies that predetermine conditions to be imposed upon children whose needs remain uncertain and unpredictable.

Theoretical Conflict

The researcher has taken the position that humans transform to higher, as opposed to just differentiated states. Borrowing from Prigogine and Stengers' (1984) concept of "order out of chaos," and their association of entropy with the "arrow of time," the researcher has interpreted the transformation as being both enhancing (by the establishment of order) and forward moving (with the one-directionality of the arrow of time).

Relating this to Kelley and Rasey's (1952) discussion of tropism (a plant's movement toward light for self-sustenance), the researcher has considered entropy to be a connotation of a higher plane of existence that surpasses the maintenance of tropism. Additionally, Kelley and Rasey's description of inanimate objects transforming from order to disorder (e.g., a rock's transformation into dust), suggested to the researcher a diametric relationship. If inanimate things transform to disorder, then living things must transform to higher orders of enhancement.

The conflict in taking the position that development is forward-moving rests with the fact that linearity can be implied. It can be argued that: 1) Maslow's hierarchy is another stage theory, 2) entropy is nothing more than a measure of messiness (Pagels,1982), and 3) most of the humanistic psychologists infer that development implies progression and improvement which, again, suggests linearity.

In regard to Maslow's theory being a "stage theory," it appears that his thinking transformed over the years from the linear stance to nonlinearity. Maslow (1962) states that the step-wise conceptions are to be discouraged, and that self-actualization is "a dynamic process" (p. 24). It can, therefore, be argued that Maslow broke away from his earlier, linear postulates.

From a physics perspective, the assertion that entropy is merely a measurement device for estimating the messiness of a system alludes to the fact that entropy is value-free. In a purely scientific context, entropy cannot be concerned with the highness, or improvement, of a system's state. The entropy measurement only indicates the degree to which the system has undergone change.

Finally, in regard to the humanistic theorists being linear in their thinking, it is true that nearly all tend to speak of higher states. Rogers (1977) describes the highly developed person as fully-functioning; Maslow (1962) uses the term, self-actualized. Combs (1982) refers to the transformation as a new state of heightened consciousness.

As the study has shown, each of the humanistic theorists seems to support the assumptions that development follows random, nonlinear, irreversible and uncertain processes. Yet only May (1975) describes the transformation in a way that parallels how a chemist, or a physicist, might describe the bifurcation process. And Rogers (1969) encourages a "no agenda" meeting. This leaves the meeting totally at the mercy of randomness and nonlinearity--chaos!

In sum, it must be noted that the researcher's conclusions state that, when applied to the development of humans, entropy refers to bifurcations which are rejuvenating and enhancing, not merely self-sustaining. Paradoxically, however, it can be asserted that entropy is a neutral means of measuring change which has noting to do with attaining a higher, more refined state. Finally, depending upon how May's and Rogers' theories are interpreted, it can be said that these theorists are in agreement with Maslow, Combs, Allport, and Kelley. Or it can be said that May and Rogers are theorizing out of a different conceptual base.

This study provides enough evidence about the theories of these men to postulate an argument either way. This can also be said for the issues of Maslow's stage theory and the researcher's application of the physics term, entropy. Because these issues can be argued in different ways, they remain paradoxical. However, paradox seems to be a characteristic of transformational theory since it holds that phenomena of the universe cannot be known with certainty.

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