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A BEHAVIORAL SYSTEMS THEORY OF DEVELOPMENT

UNA TEORÍA CONDUCTUAL DE SISTEMAS DEL DESARROLLO

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ABSTRACT

Behavioral Systems Theory (BST) is the confluence of principles from behavior analysis and dynamical systems theory applied to human development. BST takes a natural science approach to the study of the changes in behavior/environment relationships over the lifespan. In BST, simple mechanisms produce complex developmental outcomes. The parallelism between natural selection and learning is emphasized and the importance of principles of operant learning in development is stressed. Development is considered to be multidirectional, multiply determined and multileveled. Among the BST principles described are reciprocal determinism, nonlinearity, coalescent organization, leading parts, control parameters, and attractor states. The role of contingencies in organizing patterns of behavior is presented. Weight is placed on development as skills learning.

Key words: dynamic systems, behavior systems, human development, operant learning

RESUMEN

La Teoría Conductual de Sistemas (TCS) integra los principios del análisis de la conducta y los de la teoría de sistemas dinámicos, aplicada al estudio del desarrollo humano. La TCS aborda el estudio científico de los cambios del comportamiento y de sus relaciones con el entorno. En la TCS algunos mecanismos que son simples producen un desarrollo complejo. En este artículo se enfatiza el paralelismo entre la selección natural y el aprendizaje y se subraya la importancia de los principios del aprendizaje

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operante durante el desarrollo. El desarrollo es considerado como un proceso multidireccional, producido por múltiples causas y niveles. Entre los principios descritos en la teoría de sistemas están: el determinismo recíproco, la no-linealidad, una organización por conjuntos, los segmentos primordiales, los parámetros de control y los estados de atracción. Se discute el papel que desempeñan las contingencias en la organización de modelos del comportamiento. Se pone énfasis en el desarrollo como resultado del aprendizaje de destrezas.

Palabras clave: sistemas dinámicos, sistemas conductuales, desarrollo humano, aprendizaje operante

Recently, dynamical systems theory has generated much interest among two fields which have seldom shown much commonality, developmental psychology and behavior analysis. Thelen and her associates (Thelen & Ulrich, 1991; Thelen & Smith, 1994) have generated interest among mainstream developmental psychologists. Similarly, Marr (1996) has made a case for the compatibility of behavior analysis and dynamical systems theory. Recently, Novak (1996) published a textbook which brings together developmental psychology and behavior analysis by using a dynamical systems framework. The resulting theory is called Behavioral Systems Theory (BST). The basic principles of BST are described in this paper.

Some have suggested that dynamical systems approaches invalidate or, at the least, are incompatible with behavior analysis. Instead, dynamical systems approaches enhance behavior analysis by extending it (Novak, 1995). These extensions are particularly helpful in studying human development. Dynamical systems approaches enhance radical behaviorism in much the same way that, in physics, dynamical systems principles extend and elaborate Newtonian mechanics. That is, dynamical systems principles do not invalidate the laws of physical science, but rather they enhance prediction and control of the other principles under conditions where they might not otherwise apply. Likewise, dynamical systems principles may strengthen our prediction and control of behavioral development, too. BST is an extension of a behavior analysis of child development originally set forth by Bijou and Baer (1961).

Human Development and Dynamical Systems

Developmental psychology is a good fit for dynamical systems, especially chaotic systems. This is the subfield of dynamical systems concerned with random variation imbedded in systematic variation. Dynamical systems approaches have been recognized as important by developmental researchers (e.g., Fischer, Bullock, Rotenberg, & Raya, 1992). An increased emphasis on "context" in developmental science has led to renewed interest in systems theories. While influenced by general systems theory (e.g., von Bertalanaffy, 1962), more specific developmental systems theories such as the epigenetic models of Gottlieb (1997) and Oyama (1989), Ford and Lerner's developmental systems theory (1992), and especially Bronfenbrenner's ecological model (1979) have influenced current mainstream developmental thinking. This shift toward systems thinking has provided conditions for the emergence of dynamical systems approaches, particularly the work of Esther Thelen, in developmental psychology.

Originally, Thelen and her associates focused on the development of motor skills (e.g., Thelen, Kelso, & Fogel, 1987; Thelen & Ulrich, 1991). Recently, they have expanded dynamical systems to other areas of child development, including the study of language and cognition (e.g., Thelen & Smith, 1994). Thelen's view, called "Dynamic Systems," shares many tenets with BST.

BST: Development as a Natural Science

BST views human development as a natural process that can be understood from a scientific perspective. BST is a science of the changes in behavior/environment relationships over the lifespan. Development is analyzed in a way that is consistent with analysis in other sciences. Behavioral and environmental events are observable and thus valid phenomena for scientific study. While these events may be reduced to more fundamental phenomena and studied at the biological, chemical, or physical level, BST rejects such reductionism as robbing behavior/environment relationships of their own emergent properties.

Simple Mechanisms Produce Complex Development

One criterion for evaluating a science is its parsimony (Thomas, 1992). That is, can a phenomenon be explained with a few, powerful explanatory mechanisms? This principle of parsimony is derived from a scientific analysis of nature, where simple, but powerful mechanisms explain much. A science of behavioral development should be parsimonious, too. Some view behavioral explanations as simplistic. Yet, simple, but elegant explanations are a goal since they are more like laws in other natural sciences. Simple does not mean simplistic.

The human developmental process is enormously complex. Naively, it could be assumed that the mechanisms themselves must be complex too. For example, it is argued that language development requires a highly sophisticated special mechanism, a language acquisition device (LAD), to produce the complexity of human language in children. BST takes the position that complexity is the result of many simple processes combining in unique ways over many trials.

This marks a change from traditional developmental viewpoints. Similar changes in perspective have occurred in other sciences. Among these is the change in perspective on inheritance of physical characteristics. Prior to Mendel's identification of genes as the mechanism for the transmission of human characteristics, complex structures such a homunculus were believed to be involved. Today, our acceptance of a genetic mechanism is universal, even by those who do not appreciate the remarkable simplicity of the genetic code, a code fundamentally determined by only four bases. Thus, the staggering complexity of living organisms is created by the unique combination of these four simple bases. Likewise, in BST, complex behaviors develop from the combination of many simple behavior/environment events. It is the combinations of enormous numbers of these events over time that produce complexity.

Natural Selection and Learning

Consistent with a natural science approach is the view that the process of child development parallels the process of evolution. Developmental psychology focuses on changes in individuals (i.e., ontogenesis), whereas evolution focuses on changes in species (i.e., phylogenesis). Both ontogeny and phylogeny depend on selection by consequences.

A natural science approach to development requires a parsimonious and powerful mechanism for effecting change, selection. When referred to as "natural selection," selection by consequences has been accepted for over one hundred years as the primary mechanism for changes in species characteristics over phylogenic time. Selection has been applied in behavior analysis to ontogenesis (e.g., Skinner, 1981; Donahoe, Burgos, & Palmer, 1993). Selection by consequences is an attractive alternative to more complex views of change since it provides a simple set of mechanisms capable of producing great complexity. Moreover, the agent of selection is the environment, not some hypothetical internal agent. Selectionist accounts of change require three fundamental mechanisms: variation, selection, and retention (Donahoe, et al., 1993).

Variation is characteristic of behavior. Behavior analysts assume that when behavior is repeated, it will not be an exact match of a previous response but will be part of a response class. The class can be narrow, with little variation, or broad, with much inter-response variation. Siegler (1994) has described the variation existing in human cognitive development. He concludes that variation is the rule, rather than the exception in children's cognitive responses. Further, variation is not only present between children, but also is present among the responses of individual children.

Variation enables selection (Donahoe et al., 1993). That is, variation enhances the likelihood that a more functional behavior will occur. Consequently, this more functional behavior can be selected by contingencies of learning. This is what happens in shaping through successive approximations. Because there are, on occasion, responses that are better environmental fits, these new behaviors can be selected. Selection can occur by the experimenter controlling the operant chamber, or by natural consequences in the real world of children. Reinforcement is the central mechanism for ontogenic selection by contingencies.

Learning and Development

BST considers unlearned as well as learned behaviors. Unlearned behaviors include reflexes and perceptual responses. Some experience or exposure to the environment may be necessary, but these stimulus-response relations are largely the result of species-wide natural selection. Reflexes were selected because of their function in the environmental niches our ancestors occupied. Many, such as the startle reflex, eye-blink reflex, and swallowing reflex continue to provide adaptive functions for infants. The functions of infant reflexes can be classified into categories including consummatory, avoidance, and social functions. While these unlearned responses constitute much of the neonate's behavioral repertoire and early functioning, they soon are supplanted by learned responses. Thus, learning, characterized by changes due to environmental consequences, plays the key role in development. In BST, respondent type learning plays its most significant role in the development of emotional behaviors. It is operant learning which plays the central role in development (Horowitz, 1987).

BST is consistent with most modern developmental theories in viewing as meaningless, questions about the relative importance of nature versus nurture. Anastasi (1958) suggested that the question regarding heredity and environment should be "how" rather than "how much." The former leads us to investigate the processes by which nature and nurture transact. The latter leads to non-productive qualitative statements about which is more important (Lamb, 1994). Development is 100% nature--and 100% nurture.

Development is Multileveled

Some have questioned the relevance of basic behavioral principles to the development of phenomena such as cognition or language. One way to appreciate the relationship between basic principles and emergent, organized patterns of behavior is to view development as occurring concurrently at four different levels of systems (Horowitz 1987). These four levels of systems are: (a) basic processes, (b) emergent response classes in which higher-level behaviors (e.g., stimulus equivalence) result from more basic processes, (c) transactions between systems (e.g., social systems), and (d) cultural and societal systems (Novak, 1996). A central concept here is that all four levels are contemporaneously present in development. These levels can be represented through the metaphor of a work of art. A great painting, such as Seurat's "A Sunday Afternoon on the Isle of La Grand Jatte," can be analyzed on many different levels, depending on the focus of the observer (Novak, 1996). Seurat's pointillism was founded on scientific theories of color. Consequently, the apparently random location of colored dots was actually quite carefully chosen. In the metaphor, the dots are the basic processes of development, such as genetics and learning. That is, the dots form the foundation, without which there would be no painting (nor development). Furthermore, out of these thousands of brushstrokes emerge organized forms. These organized forms are the metaphoric equivalent of the next level of developmental analysis. Just as children, animals, and adults emerge out of the dots of paint, so to do organized patterns of behavior, such as language, cognition, and personality, emerge out of the basic processes.

In the painting, relationships emerge from the relationships of figures to each other. From the individual figures of a woman and child holding hands emerges a social relationship between mother and daughter. Likewise, the individual behaviors of children and their parents become social phenomena with unique characteristics. Finally, as the painting conveys a unique sense of time and place, so too does development. We may validly attempt to understand the effects of welfare or school reform on children, or understand the special role that Mexican culture plays in shaping Mexican children.

Again, it is important to realize that all of these systems are present concurrently. It is we, the observers, who choose the level of analysis we find most relevant to a scientific or applied issue. As behavior analysts, we often are most interested in basic processes, such as reinforcement contingencies. Without these there would be no development. But developmentalists may be more interested in the unique emergent qualities we find in behavior that result from the action of basic processes, rather than the processes themselves. We should all be concerned with analyzing development at the appropriate level of systems for the phenomena we are studying.

Mechanism and Contextualism

The argument over whether the appropriate world view for behaviorism should be mechanism or contextualism has raged over the past decade (e.g., Marr, 1993; Morris, 1993). It may be that both are correct. That is, mechanism may serve as an appropriate metaphor for much of behavior analysis, just as it would for much of physics. However, contextualism, particularly since its root metaphor is the historical act, may be appropriate for a behavior analysis of development. This is because development means change over time, and the organism's history of interactions is relevant, as well as the role of *multiple influences* in these behavioral interactions (Peláez-Nogueras, 1996). Thus, when Behavior Systems Theory is analyzing at the level of basic processes, it is mechanistic, when it analyzes changes over ontogenic time, it is contextualistic.

Behavioral Systems Principles

Since operant learning is considered the process in development, the four-term contingency is central to BST. The theory adds setting events (Bijou & Baer, 1961), establishing operations (Michael, 1993), or contextual interactants (Peláez-Nogueras & Gewirtz, 1997, p. 37) to the traditional three-terms of discriminative stimulus, response, and consequence. The setting event or contextual variable provides the context within which the rest of the contingency can function. The contextual variables participating are important in analyzing developmental dynamics because such contextual factors (as well as behavior and stimulus functions) are established through the organism's long-run history of interactions with the environment.

Multiple Determination

Even simple behaviors result from many determinants. In human development, this includes a vast array of initial conditions plus the changes in conditions resulting from transactions. Complex human behaviors emerge from the convergence of simple but multiple causes. Dynamical systems principles suggest that simple processes can combine to produce complex outcomes.

Although there are many ways to classify the primary classes of initial conditions, Ross (1980) identified four sources: genetic-constitutional make-up, history of interactions, current physiological conditions, and current environmental conditions. A fifth factor, behavioral dynamics (Novak, 1996) is the contributions that the process of developmental change itself has on development. Variables representing all five factors are in constant reciprocal interaction.

Reciprocal Determinism

In 1961, Bijou and Baer provided the following formula for behavioral development "B = f (S) This is read as: Behavior (B) is a function (f), or is a consequence of, stimulus events" (Bijou & Baer, 1961, p. 8). This suggests a unidirectional view of development in which the environmental conditions, including stimuli that have acted in the past, effect behavior. However, inherent in a behavioral systems view is reciprocal determinism, in which any part of the system affects other parts. Thus, the organism's behavior affects the environment in the same sense that the environment affects behavior.

As scientists we may choose to identify a causal and a dependent variable, but we must also be aware that we could reverse the roles. Thus, while behavior may be a function of the environment, the changes in the organism's behavior brought about by the environment may, in turn, change the environment. Thus, this newly changed environment will have different effects on the organism's behavior than before. The term transaction has been used to describe reciprocal interactions in which the environment affects the organism and the organism affects the environment (Horowitz, 1987; Sameroff, 1975).

While it may be easy to see how a combination of different factors can produce different developmental outcomes, it is not always easy to see how similar outcomes may be the result of different combinations of events. Developmentalists call the later "equifinality" (e.g., Horowitz, 1987). Thus, three children may have identical behavioral topographies that have led to their diagnosis as attention deficit disorder (ADD). However, they may have developed these topographies under different interactional histories. Behavior analysts have long accepted that topographically similar behaviors may be the result of different functional learning histories.

Nonlinearity

Behavioral Systems Theory follows a nonlinear model that emphasizes the reorganizing effects of bi-directional interactions or transactions. A nonlinear model goes beyond a simple transactional model to predict changes that are not only additive, but may be exponential. The result is a qualitative, not just a quantitative change in behavior. Consider the following example. A smiling baby (A1) increases smiling in the presence of her mother (B1). This increased maternal smiling (B1) in turn may increase still further the baby's smiling (B2).

At this point the increased smiling of the baby (A2) has further effects on mother's behavior (B2). Up to this point, the interaction is linear. However, now, the high rate of baby smiling may cause mom's smiling to be replaced by an emergent behavior, laughing (X1). Laughing is qualitatively, not just quantitatively different from the behavior which came before. This is qualitative change is a nonlinear phase shift.

Note the dynamical changes occurring in these interactions. Clearly the history of child-parent interactions (i.e., the preceding events) affects the current interactions between them. The transactions have been reorganized in that the earlier system of smiling/smiling has become a system of smiling/laughing.

In addition to bi-directionality, a nonlinear model connotes disproportionality. Consider the action of a drinking fountain. You press the handle and water barely trickles out of the spout. You press just a little harder and it produces a little more flow, but still not enough to get a full drink. So, you press a little harder still. Suddenly the fountain erupts, hitting you in the eye. Now, consider again the example of the smiling baby and her mother. Initially, small increases in the baby's smiling may at first produce small, proportionate increases in the mother's smiling. Additional small increases in the baby's smiling may lead to no further changes in the mother's level of smiling. However, still additional increases in the baby's smiling may lead to a drastic, disproportionate change in the mother's smiling, perhaps inducing a burst of laughter. Lorenz (1977; cited in Zimmerman & Whitehurst 1979) calls this "fulgeratio," a creative flash in which the systems resulting from the combination of other systems have emergent properties that are not reducible to a more basic level.

BST views development as a continuous process. From conception to death, the changes in person/environment relationships are based on what has come before. Yet, as the nonlinear model suggests, not all changes are simple incremental additions to the person's repertoire. Instead, there may be sudden, abrupt change, as when a baby progresses from crawling to walking. Walking is based on what has come before, the crawling, but it is not just a faster or stronger form of walking. Walking is qualitatively different. While based on earlier forms, walking has emergent properties that are not just linear extensions of crawling. While small, incremental changes may occur in development, at times change is more dramatic and irregular. In dynamical systems approaches, these sudden changes are called "phase shifts." More traditional developmentalists use the term "stages."

While stages have been widely used in developmental psychology, other sciences have also had to contend with the sudden emergence of qualitatively different states. Physical objects frequently make sudden changes from one qualitative state to another. For example, as water drops to 0 degrees Celsius (32 Fahrenheit), there is a qualitative shift to the crystalline structure. Water emerges as ice. Gleick (1987) uses the example of applying increasing force to a metal bar. At some point, the bar just crumples, shifting from one state (i.e., straight) to another (bent). This sudden, qualitative change in properties is a phase shift.

Thelen and Ulrich (1991) illustrate the nonlinearity of phase shifts. They point to the sudden shift in the gait of horses from walking to trotting. With just a small increase in speed, the pattern of the horse's hoofs shifts suddenly. Trotting is not just more rapid walking; it is qualitatively different. A completely different pattern emerges from the increase in speed. The switch from walking to trotting is a phase shift. Behavior analysts see phase shifts suddenly emerge in much of their work. In shaping, a large number of reinforced approximations may produce only linear changes, but a single reinforced approximation may produce a nonlinear phase shift.

Phase shifts have four characteristics that they share with what traditional developmental theorists describe as stages. First, they are sudden. A child cannot walk at all, and then suddenly takes his first steps. Second, the order of phase shifts in development is often predictable. That is, we can predict that children will crawl before they walk. Third, the new behavior is different in form from the behaviors that preceded it. The walking that emerges is different in appearance from crawling. Fourth, the form and often the timing of the phase shift is predictable within a species. Behavior analysts often see phase shifts: the emergence of a transitive relation, or the sudden movement of the bird to the food hopper, are examples of phase shifts. Piaget was able to predict a shift at about two years of age from the sensorimotor stage to the preoperational stage of cognitive development. In addition, he could predict what the differences in behavior would be in a child. However, the phase shift or "stages" do not explain the shifts in behavior: they are descriptions of the changes in topography or its organization. How, then, do we explain such sudden phase shifts or "stages"? To do that we must identify the conditions and how they come together to produce re-organization of the behavior/environment interaction.

Coalescent Organization

Phase shifts in behavioral development occur when all necessary and sufficient conditions, both current and historical, are present. The coming together of these conditions produce the emergence of a new form of behavior. This coming together of conditions to produce a phase shift in behavior is called "coalescent organization" (Novak, 1996). For example, the individual conditions necessary to produce the shift from crawling to walking in infants may already be present long before the child can walk. These include physiological changes, such as an increase in muscle strength and decrease in proportional weight of the head to rest of the body. It also includes a history of interaction that may include, in addition to crawling experiences, pre-walking help provided by parents. Finally, there are the contingencies for walking which develop in part through previous crawling experiences. At some point these conditions, which are necessary and sufficient conditions for walking, come together in a time and a place. There is a sudden phase shift from crawling to walking brought about by the coalescence of these conditions. Like most attractors, walking is initially a loose assembly of component skills, easily perturbed by small environmental changes that can prompt the unstable toddler to take a tumble. Thus, an important property of coalescent organization is that the form of the response is assembled by the particular task at hand (Thelen, et al., 1987). That is, the form of the response is organized by its function or consequences.

Thelen and other dynamic systems theorists have called this principle "self-organization." (e.g., Thelen & Ulrich, 1991; Thelen & Smith, 1994). However, this connotes an organizing agent. But the organization is in the natural coming together of conditions--the coalescence.

Leading Parts and Control Parameters

In considering the principle of multiple determination, it is necessary to note that some factors disproportionately affect outcome. Horowitz (1987) calls these factors "leading parts." A mother in a nuclear family is a leading part for much of what develops in that family. For example, a small increase in praise from the mother may disproportionately increase room cleaning by the child. Another example of a leading part in development is the disproportionate effect the emergence of walking has on social behavior. Likewise, the attainment of muscle and bone maturation is a leading part in the development of walking (Thelen & Ulrich, 1991). The presence of these factors at specific levels may determine the outcome of a behavior. When this occurs, these levels of these factors are called *control parameters* (Thelen, 1989). Control parameters are conditions that produce phase shifts. In other words, they are the conditions that control the development of emergent behaviors.

Behavioral Attractor States

Behaviors that emerge from organism/environment interactions may have consistent forms or topographies. Thelen and Ulrich (1991) have used the terms dynamic attractor, attractor state, or simply, attractor, for the consistent pattern that emerges as the result of coalescent organization. Thus, crawling, walking, babbling, and other functional response classes having a specific form and assembled by the task at hand (i.e., having a specific function) are attractors.

The term *attractor* may suggest that it is the behavior itself that attracts. That is, the term suggest that the attractor assembles the components into the emergent behavior. This is not the case. The term attractor is only a description of the emergent behavior. The attractor is the pattern that is assembled by the coalescence of conditions brought together by the task at hand. For example the whirlpool pattern that emerges when water goes down a drain is an attractor. It is assembled by the coalescence of conditions, including the amount of water, shape of the sink, size of the drain, gravity, and the location of the sink (e.g., the whirlpool rotates in a clockwise direction in the northern hemisphere, it spins counterclockwise in the southern hemisphere). The whirlpool emerges from the coalescence of factors; the whirlpool does not organize the factors into itself. However, behavior dynamics suggest that the emergence of an attractor may contribute to the organization of a system such that the attractor state is more likely to be maintained. For example, the emergence of the whirlpool affects the surrounding environment in ways that make the swirling attractor more likely to continue. Similarly, in behavior analysis, "behavioral momentum" is a case where reinforcing a particular topography of behavior (a behavioral attractor) makes it more likely that behavior will continue.

In BST, phase shifts result in to the emergence of attractors. Attractors are consistent patterns of responding and are equivalent to response classes. In behavior analysis, new functional response classes emerge from organism/environment interactions. As described by Thelen and Ulrich (1991), these attractors are initially "soft assemblies" of behavior. This suggests that in the early stages of the organization of behavior (e.g., as in the early days of walking) there is a great deal of variability and susceptibility to perturbance. Behavior analysts have frequently noted the increase variability and fragility of response classes in the initial phases of skill learning. Recently, Binder (1996), Lindsley (1996a, 1996b), and others have emphasized the importance of fluency in the development of academic skills, including reading. Fluency leads to "hard" or at least harder assemblies, and results from overlearning of skills (Dougherty & Johnston, 1996). Dynamic systems theorists may find such fluency occurring naturally in developmental epigenesis. It may be this fluency that produces the phenomena developmentalists refer to as "canalization."

The nonlinearity extends to new classes of responses during development. Rosales-Ruíz and Baer (1996), introduced the concept of "developmental cusps" to describe changes in person/environment interactions that enable multiple new interactions. That is, a developmental cusp is a change, such as walking which, because it has occurred, enables the explosive development of many new interactions, such as social behaviors, exploratory behaviors, and a host of others. Baer and Rosales (1994; Rosales & Baer, 1994) liken a developmental cusp to a node of a tree branch. As with the tree, a developmental cusp develops from earlier branches, and like a node, it leads to many later branches, none of which are predetermined nor precisely predictable. The explosion of multiple branches of development that are made more probable by a cusp is consistent with the dynamical principle of nonlinearity.

Organization by the Task or Contingencies

While the organization of emergent behavioral attractors may depend on the coalescence of many factors, the role of the task (i.e., contingencies of reinforcement) is crucial. Thelen and Ulrich's (1991) examination of the development of treadmill stepping illustrates the importance of the task for the emergence of a skill. Their monograph shows that by varying treadmill characteristics (e.g., supporting the child's weight, changing the speed and consistency of the treadmill belt) bipedal walking can occur many months earlier than under more species characteristic environmental conditions. Behavior analysts have long emphasized the importance of contingencies, particularly reinforcement contingencies for organizing functional response classes. "Contingency adduction" (Andronis, 1983) is a term that describes the sudden coming together component skills into new combinations by contingencies of reinforcement. Johnson and Layng (1994) describe the "curriculum leaps" that are made possible by contingency adduction. This is a good example of nonlinear phase shifts that occur through coalescent organization.

Skills Learning

Development as the acquisition of skills is a central part of BST. There are six important characteristics of skills (Novak, 1996). First, skills are organized functional response classes. Second, skills develop over periods of time during which perhaps massive numbers of behavioral trials or learn units occur. Third, skills develop through environmental influences Fourth, components of skills may present but undetected prior to being assembled through coalescent organization. Thelen and Smith (1991) call these "hidden skills." Fifth, consequences are among the most important environmental influences for assembling skills. Finally, the unit of analysis for skills is the four- term contingency.

Besides being compatible with behavioral theory, a skills learning approach has the important feature, that it is consistent with observable conditions. Moerk's analysis of the intuitive use of the three-term contingency in mother-child language interactions (Moerk, 1990) is an example of this.

CONCLUSIONS

Behavioral systems theory combines recent advancements in the application of dynamical systems principles in human development with behavior analysis. It views human development from the perspective of a natural science of the study of the progressive changes in interactions between the person and the environment. Development is the result of ever-changing, bi-directional organism/environment interactions producing continuous, but frequently, nonlinear changes. Dynamical systems principles extend, rather than replace a behavior analysis of development that can be traced to the work of Bijou and Baer (1961). It remains to be seen whether BST principles designed to extend the Bijou and Baer principles will turn out to be just a case of "old wine in new bottles." My hope is that it will result in additional productivity in behavioral theory and developmental psychology.

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