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# Concepts in Behavioral Development

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*This essay attempts to clarify the meanings of some of the concepts encountered in the field of behavioral development (and indeed in psychology in general) such that their use may lead to a more coherent and consistent theoretical view. The essay considers meanings of the concepts of development, behavior, environment, behavioral causation, learning, cognition, brain, and theory with the goal of reducing any confusion and ambiguity currently associated with them.*

Many concepts in developmental psychology are derived from a variety of theoretical approaches that, when considered as a whole, do not offer a unified understanding of development. Although several factors are responsible for this state of affairs, one is surely the lack of serious investigation into the concepts themselves. In addition to the concept of *development*, other concepts (e.g., *schema*, *attachment*, and *cognition*) are often vague and ill-defined, thus leading to confusion. According to Machado, Lourenço, & Silva (2000), the problem of confusion may be solved by carrying out conceptual investigations and, as they point out, such conceptual investigations are really grammatical investigations when applied to so-called weak theories -- "any set of loosely interrelated verbal statements about an empirical domain" (p. 23). They explain:

> The closer a theory is to the weak end of the spectrum . . . the greater the need for conceptual investigations of the theory. The reason for this conclusion is straightforward. Lacking quantitative concepts and explicit principles and laws, a weak theory requires the assistance of extraneous factors to regulate the use of its concepts—extraneous in the sense that they are not an explicit part of the theory. One of the most important of these factors is the pattern of use in everyday language of the concepts of the theory, what we might call following Wittgenstein their "conventional grammar." In weak theories then, conventional grammar plays the role that scientific principles and laws play in strong theories. However, this grammar is seldom analyzed, for we learn to speak and understand a language and use its concepts appropriately in a bewildering variety of contexts, but not to analyze the language's semantic patterns. This then is the major reason for a conceptual analysis in weak theories (pp. 23-24).

Behavior analysts interested in development have generally done a good job of investigating concepts in their own discipline, including the concepts of *development* (e.g., Baer & Rosales-Ruiz, 1998; Bijou & Baer, 1978), *environment* (e.g., Baer, 1997), *contextualism* (e.g., Morris, 1998; Reese, 1991), and the concept of *concept* itself (e.g., Etzel, 1997). Behavior analysts have even tackled more traditional concepts such as *attachment* (e.g., Gewirtz, 1972; Gewirtz & Peláez-Nogueras, 1991) and *social referencing* (Gewirtz & Peláez -Nogueras, 1992). However, these conceptual investigations are directed mostly at sophisticated behavior analysts, and few treatments have investigated more than one or two of these concepts at a time.

The present essay analyzes the grammar of several of these concepts and, thus, offers a general guide for navigating through the conceptual landscape of behavioral development. Specifically, the essay provides a road map for thinking about ontogenetic behavioral development, that is, the systematic changes in environment-behavior interactions beginning at birth. The specific changes that occur will not be detailed because that information is available elsewhere. Rather, the current treatment looks at many of the concepts students and scholars of behavioral development will encounter, beginning with the concept of *development* itself. The essay then considers the concepts of *behavior*, *environment*, *causation*, *learning*, *cognition*, the *brain*, and, finally, *theory* in behavioral development and concludes that when these concepts are clarified, there may be little distinction between a science of behavioral development and a science of behavior.

## The Concept of Development

In general, *development* refers to change over time. With respect to organisms, however, we can talk about *development* over two time periods -- evolutionary time, called phylogenetic development, and the lifetime of individuals, called ontogenetic development. These two periods of development imply changes in two different units of study. Phylogenetic development (i.e., biological evolution) refers to changes over evolutionary time in genes beginning approximately 3.6 billion years ago. The process responsible for phylogenetic development is natural selection, a process in which ancestral environments selected phenotypes, that is, physical traits including behavior (and hence underlying genotypes). Ontogenetic development refers to changes over the lifetime of individuals beginning at conception, although practically speaking, behavioral development begins at birth. The major process responsible for ontogenetic development from conception until birth is the genetically determined biological process termed *maturation*, which operates relatively independently of the environment (e.g., Dworetzky, 1996). Beginning at birth the processes determining behavioral development (i.e., behavioral evolution) are maturation and experience, the latter defined generally as the interaction of behavior with the environment. The debate over maturational and experiential contributions to behavioral development is akin to the issue in psychology of nature and nurture.

## Development as Continuous or Discontinuous

Another issue of debate is whether the processes involved in ontogenetic behavioral development are continuous or discontinuous, the latter indicated by the practice of dividing development into discrete stages. Theorists such as Piaget, Freud and Greenspan proposed stage theories to account for different aspects of development (e.g., cognitive, moral, personality) based on the premise that at least certain aspects of development are discontinuous. But we can view ontogenetic development as analogous to phylogenetic development. As Grobstein (1988) has written in answer to the question of when life begins, "Human life. . . like all other life . . . . has been transferred in unbroken successions of generations since its . . . inception millennia ago -- whenever and however that is assumed to have occurred" (p. 23). This implies that phylogenetic development is continuous.

Of course, there have been singular, and often, catastrophic events throughout the history of the earth that have produced major and significant changes in the evolution of life, the most well known of which may be the catastrophic event (now almost universally believed by scientists to have been a 10-kilometer-wide meteorite that produced the Chicxulub Crater in the Gulf of Mexico and the Yucatán Peninsula about 65 million years ago). This catastrophe was responsible for the fairly quick extinction of dinosaurs and the rapid rise of mammalian variety. For ease of studying prehistory and communicating about it, geologists and pre-historians divide the earth's history into eras, periods, and epochs (for example, the extinction of the dinosaurs occurred during the Cretaceous Period of the Mesozoic era). Although, at least in historical hindsight, such divisions may be marked by seemingly punctuated events (e.g., submergences of the continents and changes both in the earth's surface and in its flora and fauna), the processes responsible for geological and organic evolution are viewed as continuous and ongoing.

The same approach may be taken with respect to ontogenetic development. The development of individuals from conception until death is also a continuous process, even though there may occur singular and sometimes catastrophic events (e.g., teratogenic effects, injury, etc.). Developmental psychologists (and even biologists) divide ontogenetic development into stages for ease of study and communication about changes in individuals, even though the processes responsible for the changes are continuous. However, just because some theorists impose stages *a posteriori* doesn't mean that such stages are inherent properties of behavioral development itself.

Although other problems with stage theories in developmental psychology have been noted (Lipsitt, 1981), one obvious problem is that any relatively universal changes in children's behavior may be a function of a common genetic heritage or common experiences. Unfortunately, the concept of stages has most often implied common genetic heritage. Either way, simply describing the change and classifying it according to a stage of development does not contribute to discovering the ultimate causes (see below) or processes responsible. One alternative to a strict stage theory is to borrow a page from geologists and divide development into time periods as long as there are relatively universal changes that coincide with the approximate beginning and end of the period. For example, rather than distinguishing between sensorimotor and preoperational *stages* based rather arbitrarily on the presence of some phenomena such as object permanence and the inference of unobserved changes in cognitive structures, as Piaget did, it might be more productive to mark the boundary between the sensorimotor and preoperational *periods* by the appearance of a major behavioral milestone such as verbal behavior. In general, it might be more profitable to divide human development into time periods marked by the appearance of major behavioral or biological milestones, such as babbling (which begins when the larynx descends into the throat at 4-6 months of age), walking, puberty, etc. This tactic makes it easier to discuss milestones in an otherwise complex developmental process without the logical pitfalls of strict stage theories.

Extending our generic operating definition of *development* as change over time, we can say that behavioral development, then, refers to changes in interactions between environment and behavior over time. According to Lerner (1986, cited in Berndt, 1992), however, the changes are systematic rather than haphazard and successive rather than independent of earlier conditions, both suggesting an orderly and continuous process. This view of behavioral development is implicit in Bijou and Baer's (1978) definition of (behavioral) *development* as "progressive changes" in environment-behavior relationships, with the term *progressive* meaning only building on an existing foundation of relationships. Now let us turn to each of the components in this equation – *behavior* and *environment* – realizing that although we may discuss them separately, they cannot be separated in practice.

## The Concept of Behavior

Behavior is but one, albeit very important, function of the physical structure of individual organisms. It is literally the action of muscles and glands caused most immediately by the coordinated effort of various structures in the central nervous system. For behavioral scientists, however, *behavior* must be defined in terms of its function as any activity of the organism that changes in an orderly way with certain variables, whether the orderly relationships can be demonstrated or not (Palmer, in press). When scientists study the function of behavior, their first task, as in other natural sciences, is to discover basic units of functional analysis. They do this, as Darwin did concerning the various life forms he encountered on his travels aboard the *H. M. S. Beagle* by asking about function.

In the past 100 years or so, behavioral scientists, beginning with Pavlov, Thorndike, and Skinner, have discovered functional units of behavior called operants, respondents, and discriminated operants. Just as the discovery of the cell as a basic unit in biology integrated the disciplines of anatomy, embryology, botany, and zoology (Zeiler, 1986), the discovery of basic units of behavior can integrate the various sub-topics in psychology (e.g., developmental, social, personality, etc.) by bringing order, clarity, and unity to those topics (Schlinger, 1992). The discovery of functional units of behavior also shifts the emphasis away from structural analyses in favor of functional analyses that can potentially explain structural features of behavior (Branch, 1977).

One advantage of discovering functional units of analysis is that scientists don't become ensnared in the structuralist trap. In other words, rather than trying to discern the meaning of behaviors that appear structurally different from one another, scientists can potentially understand them according to common underlying functions. For example, the Piagetian concepts of *assimilation* and *egocentrism* and the linguistic concepts of *overextension* and *overregularization* all imply different kinds of phenomena and are often explained in terms of different underlying cognitive structures and processes. However, most of the behaviors representative of these formal categories can be understood as instances of the broader concept of stimulus generalization. Although describing behaviors in terms of *assimilation*, *egocentrism*, *overextension*, and *overregularization* is not totally without merit, it may tend to obscure the functional similarities among them, that is, that they are each instances of behavior evoked by stimuli similar to those involved in the original contingencies of reinforcement. A functional analysis is, thus, more likely to lead to a different classification system and, hence, a more unified scientific understanding.

One implication of the discovery of functional units of behavior is that behavior cannot be considered in isolation. Behavior does not occur in a vacuum, but rather in specific relationships with environmental events embedded generally in a (historical and contemporary) context rich in both internal and external stimulus events (Morris, 1988).

## The Concept of Environment

In addition to thinking about the environment in macro-structural terms, such as society or family, a functional approach to behavioral development allows us to analyze the environment in more micro-functional terms. Our working definition of *behavioral development* as progressive changes (i.e., those built on one another) in environment-behavior relationships and the discovery of basic units of behavioral analysis lead inexorably to the conclusion that functional units of behavior include environment as an equal partner. Because *environment* can be defined as all of the energy changes (i.e., stimuli) that affect (or are functionally related to) behavior at a given moment (Schlinger, 1992), we are also able to address objectively the persistent problem of the role of internal events in behavior. In addition to energy changes outside the body, called *exteroceptive stimuli*, there are also energy changes inside the body, called *interoceptive stimuli*, both of which affect specialized neurons called *sensory receptors*. Because of their location, interoceptive stimuli do not become as differentiated as exteroceptive stimuli, meaning they do not participate very accurately in discriminated relationships. For example, it is much easier to teach a child to call red things "red" and blue things "blue" than it is to teach a child to call internal stimulation "happy" or "sad." However, interoceptive stimuli (e.g., a toothache) can be effective establishing operations.

Nevertheless, if our concept of *environment* is all of the stimuli that affect (are functionally related to) behavior at a given moment, then we must conclude that the environment is not just located outside the skin, but inside the skin as well. Practically speaking, there is an obvious problem in studying the relationship between internal events and behavior -- namely, internal events are difficult to observe. For example, how does one study the relationship between the stimulation of a toothache and a child's response "my tooth hurts"? Because internal events are assumed to be physical events (i.e., stimuli and responses), they are potentially observable. However, this potential must await improvements in a technology capable of making the observations. Palmer (in press) explains, "Whether a particular response can be observed is not a property of the response itself; rather, it depends upon the vantage point, the faculties, and the tools of the observer."

We need not wait before we can achieve some scientific understanding of relationships involving internal events as either stimuli or responses. Until there is some way to objectively measure and alter internal events, behavioral scientists can understand them through extrapolation and interpretation (Palmer, 1991). In other words, internal events are assumed to function the same way external events have been observed to function. The basic units of analysis discovered with directly observable events are assumed to operate generally and universally. Having conceptualized *environment* in a more objective and functional manner, the next step is to think about how the environment participates in cause and effect relationships with behavior.

## The Concept of Behavioral Causation

We can better understand behavioral causation now that we have our working definition of *behavioral development* as systematic, or progressive changes in environment-behavior relationships and our depiction of functional units of behavior as generic stimulus-response (environment-behavior) units (Skinner, 1935). By *understanding behavioral causation*, I mean understanding what independent variables systematic changes in behavior are related to.

In the field of behavioral development (see also Peláez, this issue), just as in the broader field of psychology, behavior is said to be caused by an interaction between nature and nurture, or inheritance and experience. Because genes do not directly cause behavior, we must be careful when we ascribe any trait to genes; we inherit genotype, not phenotype. And because phenotype is always expressed in an environment, it is the consequence of an interaction. Genes code for proteins which make up the structure of our bodies, including the nervous system, muscles, bones, etc. One of the many functions of the nervous system is behavior. But perhaps even more so than other functions, behavior only comes about after significant contributions from interaction with the environment.

In addition to genes, many other types of causes are implicated in behavior. For example, it is not uncommon to hear that the brain causes some behavior, as for example, when low serotonin level (i.e., chemical imbalances) is said to *cause* depression. Cognitive events (e.g., thoughts, ideas, expectations) are also said to cause behavior, as are immediate environmental precursors to behavior, such as seeing a red traffic light *causing* one to put her foot on the brake. And, of course, consequences (i.e., reinforcement and punishment) are said to cause behavior. Using the term *cause* in all these instances obscures any differences between the respective events said to cause behavior and, thus, clouds the concept of causation.

## Proximate and Ultimate Causation

Perhaps a more productive way to understand *behavioral causation* is in terms of proximate and ultimate causal events. In discussing causation in biology, the biologist Ernst Mayr (1997), writes that

> Every phenomena or process in living organisms is the result of two separate causations, usually referred to as proximate (functional) causations and ultimate (evolutionary) causations. All the activities or processes involving instructions from a program are proximate causations. This means particularly the causation of physiological developmental, and behavioral processes that are controlled by genetic and somatic programs. They are answers to "How?" questions. Ultimate or evolutionary causations are those that lead to the origin of new genetic programs or to the modification of existing ones -- in other words, all causes leading to the changes that occur during the process of evolution. They are the past events or processes that changed the genotype. They cannot be investigated by the methods of chemistry or physics but must be reconstructed by historical inferences -- by the testing of historical narratives. They are usually the answer to "Why?" questions. (p. 67)

Alessi (1992) was the first behavioral scientist I am aware of who introduced the concepts of proximate and ultimate causation to psychology and behavior analysis, a move followed by a few others (e.g., Schlinger & Poling, 1998). These authors modified Mayr's concepts to be more compatible with psychology and behavioral causation. Thus, with respect to behavioral development, proximate causation answers "How?" questions, such as "How did that behavior come about?" The answer to this question points to both immediate environmental and neurophysiological causes. For example, suppose a parent asks a child to "Please sit down" and the child does. We can say that the proximate causes of the child's sitting were the parent's request (most likely a discriminative stimulus – $S^D$) and the changes in the child's nervous system beginning with the stimulation of auditory sensory receptors and ending with the production of muscle movements (the responses - R). Such causes have also been termed *efficient causes* (to be contrasted with *final causes*, see Rachlin, 1992) in that usually they immediately precede their effects and point to mechanisms of action. Proximate or efficient causes also include so-called cognitive or mental events (e.g., expectations) said to cause behavior, although there are serious problems when inferring events that are not observable and directly testable and whose only existence must be inferred from other events, such as the behavior they are intended to explain (Donahoe & Palmer, 1994; Schlinger, 1993, 1998).

With respect to behavioral development, ultimate causes answer "Why?" questions, such as "Why do the parent's command and the correlated neurophysical changes evoke sitting in a child?" The answer to the question of the ultimate causes of behavior points to historical variables just as the answer to similar questions about the ultimate causes of organismic traits points to historical variables. In the latter case, the historical variables lie in the phylogenetic history of the species, a history of natural selection of genotypic and phenotypic traits. In the case of behavior, the historical variables may lie in the phylogenetic history of the species as, for example, in the ultimate causation of reflexes. But for most human behavior, the ultimate causes are to be found in the ontogenetic learning history of individuals, in particular, a history of operant and respondent conditioning that select environment-behavior relationships.

As an exercise in thinking about proximate and ultimate causation of behavioral relationships, we can attempt to understand infant reflexes in terms of their proximate and ultimate causes. Consider the rooting reflex in which a head turn is elicited by stroking the neonate's cheek. The stroke of the cheek stimulates sensory receptors in the cheek that send nerve impulses to a part of the brain that then sends nerve impulses to the part of the motor cortex (among other areas) that controls the head turn. This sequence of events beginning with the stroke on the cheek constitutes the proximate (or immediate) causes of the reflex. This is *how* the reflex occurs. But *why* does it occur? This question is answered by speculating about the natural history of hominids. Thus, in the long run, infants with genes for such a trait might have had a selective advantage over infants without such genes in finding the mother's nipple more easily. This speculative natural history is *why* the head turns to the stroke on the cheek. Once classical conditioning has occurred, however, the proximate cause is transferred from the unconditional stimulus (US) (the stroke on the cheek) to the conditional stimulus (CS) (e.g., the sight, sound, touch of the mother) and the ultimate cause is the history of pairing the CS with the US.

## The Concept of Learning

Having defined *behavioral development* as systematic and progressive changes in environment-behavior relations (and by implication in their underlying neurophysical structures), having identified operant and respondent conditioning as the two major types of experience that produce changes in behavior and its underlying neurophysiological structures and processes, and having delineated two sets or levels of causation, we are ready to think about how operant and respondent conditioning cause behavioral development.

We can define *learning* as relatively permanent changes in environment-behavior relationships as a function of certain types of experiences. Although what counts as relatively permanent is debatable, the experiences refer specifically to the direct processes of classical and operant conditioning and indirect (analogous) processes involved in social learning and learning by rules (see Alessi, 1992; Blakely & Schlinger, 1987; Schlinger and Blakely, 1994).

The kinds of experiences that produce learning do not really operate until birth (c.f. DeCasper & Fifer, 1980; DeCasper & Prescott, 1984; DeCasper & Sigafoos, 1983). At that time, the neonate's behavior begins to interact with the rich and complex exteroceptive environment outside the mother's womb. In order to think about these learning experiences more functionally, we can classify them as function-altering or relation-altering operations (see Schlinger & Blakely, 1987; Schlinger & Blakely, 1994).

### *Relation-Altering Operations*

Most recent research shows that classical and operant conditioning occur when there is a contingency between the relevant elements of each process, meaning one element is more likely to occur in the presence of another element than in its absence. In classical conditioning, the contingency is between a CS and US; and in operant conditioning, the contingency is between a response and consequence in a particular context given a relevant establishing operation (EO). Blakely and I (Schlinger & Blakely, 1987; Schlinger & Blakely, 1994) have made the case that, all things being equal, the effect of these respective contingencies is to alter (or transfer) the behavioral functions of stimuli and, thus, relationships involving those stimuli. In the case of classical conditioning, a contingency between an initially neutral CS and a US endows the CS with US-like functions, thus, establishing an evocative (conditioned reflexive) relationship between the CS and CR (conditional response). One could say that conditioning *transfers* the evocative function of the US to the CS. Conversely, classical extinction -- uncorrelating the CS and US -- weakens the evocative function of the CS over the CR. In both cases, it is the relationship between the CS and CR which is altered.

In operant conditioning, a contingency between an operant and a consequence alters the function of both the EO in effect and stimuli present during conditioning, especially those most correlated with the response-consequence contingency, called discriminative stimuli ($S^D$s). In particular, reinforcement increases the probability that the EO and $S^D$ will evoke the relevant operant class. Conversely, operant extinction reverses the evocative functions of the EO and $S^D$ over the operant class. In general, the function of classical and operant contingencies is not to condition stimuli or behavior but to change the probabilities of environment-behavior relationships by altering the behavioral functions of antecedent environmental events. Moreover, these relationships always involve generalized classes of stimuli and responses such that any procedures will affect most if not all members of the stimulus or response class (called generalization), unless differential reinforcement procedures are used to narrow the classes (called discrimination).

Stimulus events can be classified as evocative or relation-altering (Schlinger & Blakely, 1994). Evocative operations are proximate causes and relation-altering operations are ultimate causes. We can thus say that USs, CSs, EOs, and $S^D$s function as proximate causes of their respective responses, in the sense that they evoke them; this is *how* the responses occur. But the ultimate causes of these evocative relationships lie in past environments -- in the case of US-->UR and UEO--->R relationships, in the evolutionary history of the species, and in the case of CS--->CR, $S^D$--->R, and CEO--->R relationships, in the learning history of each individual. For example, classical conditioning is the ultimate cause of the ability of a CS to evoke a CR: It answers the (ultimate) question of *why* the CS evokes the CR. Likewise, operant conditioning is the ultimate cause of the ability of both the EO and SD to evoke that is to have stimulus control over the operant class: It answers the (ultimate) question of *why* the EO and $S^D$ evoke the operant.

In addition to classical and operant processes, there are several other relationships involving operations whose net effect is to alter or transfer the behavioral functions of stimuli. For example, the correlation of an otherwise neutral operation with an already reinforcing one alters the function of the neutral operation such that it now functions as a conditioned reinforcer; in other words, the reinforcing function of one event is transferred to another event. In conditional discrimination procedures, including matching-to-sample (often used in establishing equivalence relations), the evocative function of one stimulus is altered such that it is conditional on the presence of another stimulus. Even in imprinting, the evocative function of an initially neutral stimulus (usually a relatively large moving object) is altered by simply presenting it within a critical period shortly after birth or hatching. In sum, relation-altering operations are responsible for the ontogenetic contribution to behavioral development.

## The Concept of Cognition

Much of psychology and an increasing segment of neuroscience can be described as cognitively oriented. A cognitive orientation is evidenced in a few ways. One way is that researchers describe their research using traditional cognitive terms such as *mind*, *memory*, *attention*, and *recognition* as summary terms for complex environment-behavior relationships. A more common way that a cognitive orientation can be evidenced is that researchers define their subject matter as the study of cognitive structures and processes with the understanding that such structures and processes cannot be directly observed. In such cases, researchers must observe and measure the effects of environmental manipulations on behavior or on the nervous system (see below) and then either assume that the observations reflect cognitive processes or infer such processes as the causes of the behavior (Morris, Higgins, & Bickel, 1982). Donahoe and Palmer (1994) refer to this latter strategy as the inferred-process approach. In essence, cognitive processes must always be inferred from some other datum, such as behavior or neural activity, although inferring cognitive processes from the neural activity in the absence of behavior probably never occurs. These necessary inferences lead inevitably to the invention of metaphors or formal models in an attempt to understand the nature of the cognitive processes. Although the pitfalls of this approach have been noted often (e.g., Palmer & Donahoe, 1992; Schlinger, 1993; Skinner, 1974) the growing tide of cognitive theorizing continues.

Recently, cognitive theorizing has received a boost from neuroimaging studies because such methods seem to identify the neural correlates of cognitive processes. Although several methodological problems with such procedures have been noted, their basic rationale -- to locate the neurological substrates of cognitive events -- is not well supported. Whether it is recalling words, recognizing faces, or doing arithmetic problems, what is being imaged are the neural substrates of environment-behavior relationships, the ultimate causes of which are either already in the individual's learning history or are established in the neuroimaging experiments themselves. At best, such studies identify a subset of proximate causes of behavior. Although neuroimaging studies may not provide support for the existence of cognitive processes, they do remind us that the brain is the location for a subset of proximate behavioral causes.

## The Concept of Brain

The learning processes described above are measured by their effects on environment-behavior relationships. In a manner analogous to natural selection, which operates directly on phenotypes and indirectly on genotypes, relation-altering processes operate directly on behavior (phenotype) and indirectly on neurophysiological structures (analogous to genotype) and processes in the brain. According to Mayr (1997), "Ultimate or evolutionary causations are those that lead to the origin of new genetic programs or to the modification of existing ones" (p. 67). In behavioral development, ultimate or behavioral causations are those that lead to the origin of new neural programs or the modification of existing ones. In this way, just as genes can be seen as proximate causes of the proteins they create, neural structures are proximate causes of the behaviors they create. Each answers the question of *how* things come about.

Repeatable functional relationships between environmental events and behavior can be discovered without knowledge of the brain's functions (Skinner, 1938). Skinner always maintained, however, that knowledge of underlying neurophysiological processes would help to complete the story of behavioral causation. In light of our distinction between proximate and ultimate causes, we can say that knowledge of underlying neurophysiological processes can aid scientists in answering *how* (neurophysiologically) behavior comes about but not *why* it comes about. It is, thus, a mistake to speak of the brain, as is often the case, as the (ultimate) cause of behavior. The structure of the brain, like the structure of behavior, is the combined result of the interaction between maturational and experiential processes, or, if you will, nature and nurture.

## The Concept of Theory

The science of behavioral development is in large part a historical science. According to Diamond (1997), historical sciences (e.g., evolutionary biology, astronomy, ecology, geology, etc.) are "plagued by the impossibility of performing replicated, controlled experimental interventions" because of the "enormous number of variables, the resulting uniqueness of each system, the consequent impossibility of formulating universal laws, and the difficulties of predicting emergent properties and future behavior" (p. 424).

Some of these problems also plague a science of behavioral development. But because it deals with lives in progress, a science of behavioral development is perhaps unique among the historical sciences in that it is also an experimental science. As a result, it is possible to perform replicated, controlled experiments and to formulate general principles. While there is an enormous number of variables contributing to behavioral development, and while it is true that each individual is unique in some ways, our shared evolutionary and environmental histories endow us with enough similarities to enable scientists to discover general principles governing them. These general principles become the bedrock of a particular theory of development. I have addressed the issue of *theory* in behavioral development at some length (Schlinger, 1992; 1995), and I refer the reader to those sources. For the present purposes, however, suffice it to say that a theory of behavioral development must be able to explain and not just describe systematic changes in environment-behavior relationships. Explanations of behavioral development will inevitably point to both proximate and ultimate causal factors, whether in the phylogenetic or ontogenetic histories of individuals. Interestingly, such explanations may also serve to blur any distinction between a science of behavior and a science of behavioral development.

The purpose of this essay was a conceptual, not a theoretical, investigation. That is why no particular theory of behavioral development was proffered, although a behavior-analytic theory was strongly implied. Conceptual investigations, although closely related to theoretical investigations, should not be confused with them. Machado et al. (2000) explain:

> On the one hand, conceptual investigations are always relative to a particular theory. They target a theory as factual investigations target empirical problems. Hence, in the same sense that factual investigations cannot be carried out in the absence of an empirical problem, conceptual investigations cannot be carried out in the absence of a theory. On the other hand, precisely because conceptual investigations target theories as objects of analysis, they should not be confused with them. A theoretical investigation has as its object an empirical domain and, broadly speaking, the theoretician aims at developing a set of principles that will permit anyone acquainted with them to reconstruct the relevant empirical relations, understand these relations, summarize them in economical ways, and perhaps even discover new ones; in turn, a conceptual investigation has as its object the result of the theoretician's work, in particular the core concepts of the theory, their meanings, and their grammars. . . (pp. 22-23).

The present essay has attempted to do this with respect to some of the general concepts of a behavior-analytic theory of development.

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Author's Note

I wish to dedicate this essay to the memory of Don Baer. Portions of this essay were presented at the 20th Annual Conference of the California Association for Behavior Analysis, San Francisco, CA. Correspondence may be addressed to the author, Department of Psychology, California State University, Northridge, 18111 Nordhoff Street, Northridge, CA, 91330-8255. Email correspondence may be addressed to hank.schlinger@csun.edu. I am grateful to Dick Malott, Martha Peláez, and Julie Riggott for their thoughtful and insightful comments.

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*Understanding human behavior and its development involves identifying and analyzing its causes, that is, its origin, structure, substrate, function and the contextual interacting variables. This paper discusses various types of causal explanations for behavioral development and introduces the concept of contextual variables called "interactants." It provides illustrations from infant research that suggest that behavior analysis of development is moving beyond the mere analysis of the components of Skinner's three-term contingency into a principle-based understanding of contextual variables.*

Analyses of Aristotle's notions of explanations have identified several types of causes of behavior including efficient, formal, material, proximal and final causes (e.g., Killeen, 2002; Rachlin, 1992; Schlinger, this volume). In what follows, I have attempted to broaden the historical fascination with Aristotelian causes by including the anal sis of contextual interactants in the study of the determinants of human development

*Efficient causes* are the elicitors of behavior change. These are the stimuli in the environment that trigger or elicit a change or a response. The efficient causes are identified in early behavior development because they make the early components essential for later developmental outcomes. They are what initiate a developmental change. In early human development, one of a neonate's greatest strengths for survival is starting with a full set of useful reflexes. These involuntary and automatic responses to stimuli originally have a clear adaptive value, as when infants turn their heads in the direction of a tactile (touch) stimulus to the cheek and search for something to suck, or when infants suck an object placed into their mouths, allowing them to take in nutrients. Many of these basic survival reflexes later disappear or become operant responses. Another example of an efficient explanation in development are the teratogens, which involve any environmental agent, drug, disease that causes harm to the developing fetus by triggering physical deformities, severe mental retardation, and retarded growth.

*Material causes* are the substrates, machinery, or material components that can be identified as *forming the behavior.* Geneticists use the genes and DNA strings as explanations for behavior and development once their location has been identified. For instance, one important genetic disease produced by a dominant gene is Huntington's disease, a condition that causes a gradual deterioration of the nervous system, leading to a progressive decline in behavioral abilities and ultimately to death. Another example is Fragile-X-syndrome, a leading cause of mental retardation, caused by an abnormal gene (genotype) on the X chromosome that is more likely to be expressed (phenotype) when passed from mother to child. Also, many neuroscientists and psychologists use brain imaging (MRI) and its neurosubstrates to explain behavior changes. Researchers study neurotransmitters to discern their role in behavior and emotion. For example, when imbalances occur in the brain neurochemicals, this is said to cause depression (changes in cortisol, dopamine and serotonin levels have been associated with depressive symptoms). Natural opiates, such as endorphins, which are released in response to pain and vigorous exercise (Farrell, Gates, Maksud, & Morgan, 1982) have been used by researchers to explain all sorts of good feelings and happy moods, such as the "runner's high," or the painkilling effects of acupuncture caused by endorphins. These are reductionistic explanations of behavior that often times are inaccessible to the observer; and frequently, these presumed explanations are either concomitants or outcomes of another more fundamental process or cause in which a different, more molar, level of analysis would be required, in which behavior would be seen as emerging from the organism contingent upon interactions with the environment.

*Formal causes* are models, paradigms, equations or formulas used to explain behavior. In behavioral psychology, the matching law is an example (Herrnstein, 1970). The formula states that relative responding matches the relative reinforcement produced by that responding. The matching law summarizes organism performances on a variety of schedules of reinforcement. Often times, in the absence of material, efficient, and functional causes, the formal causes are useful. Another example is the schematic model of the human information processing system (Atkinson & Shiffrin, 1968). The store model explains how information flows through a series of separate but interrelated sets of processing units, or stores. It attempts to attribute the functions of memory, retrieval, and problem solving to this schematic theoretical model. Killeen (2002) presents as examples of formal causes the traditional associative (conditioning) and computational models of learning, and he explains how these models are formulated in the languages of probability and automata, respectively. In developmental psychology, a popular model is Bronfenbrenner's (1979) ecological model of the environment in which a series of nested structures (i.e., microsystem, mesosystem, exosysstem) surround the individual. The developing person is said to be at the center of, and embedded in, these layers of systems that range from the individual's immediate surroundings, to the family, schools, society and culture. The model has been criticized because it does not provide a causal explanation of why children learn and how they process information for problem solving (it lacks a functional explanation for behavior change).

*Final causes* are the *functional explanations* of behavior change. What is the purpose of behavior? What is behavior development supposed to do or ultimately accomplish? These are questions that developmental psychologists often address. At least two types of functional causes: proximal and distal/ultimate causes can be conceived. Reinforcement is an example of proximal cause, whereas survival of the fittest, or behavior selected by long-term consequences in evolution, are seen as maintained by ultimate causation (also see Schlinger, this volume). Humans behave in ways to maximize their success and chances of survival. The study of human development is concerned with the proximate as well as ultimate causes of behavior. In the second part of this paper, I identify a taxonomy of the historical and contemporaneous variables (also called interactants) mostly in the ontogenetic learning history of individuals dynamically interacting with their environment.

A dynamic systems approach to development emphasizes that none of these explanations makes sense in isolation without specification of the other three. Killeen (2002) has also stated:

> Of all behavioral phenomena, conditioning is the one least able to be comprehended without reference to all four causes: The ability to be conditioned [both classical and operant] has evolved because of the advantage it confers in exploiting efficient causal relations (p. 137).

In the dynamic systems approach of Novak and Peláez (in press), the efficient causes are seen as initial conditions for behavior development (reflexes into operants) whereas the final causes are seen as the terminal conditions (e.g., reinforcement, evolution). The functional causes are not considered as alternatives to efficient causes but as complementary, an inseparable functional and dynamic unit. (For other discussions on efficient vs. final explanations, see Rachlin, 1992).

Thus, these are all complementary causes: the *efficient* (triggers), *material* (substrates), and *final* (functional) causes can be identified in the *formal* cause of the three-term contingency model Sd----R----Sr in which: (a) the efficient causes reside in the controlling/interacting antecedent stimuli (e.g., Sd) and on the contextual organismic variables (e.g., initial boundary conditions like deprivation and the eliciting/triggering effects of environment); (b) the material causes reside in the deconstruction of the R into the substrates of both overt response (e.g., speech activity) and also the covert-activity such as the neurological; (c) the functional causes reside in the Sr or controlling consequences (e.g., schedules of contingencies).

## Discriminative and Reinforcing Functions of Stimuli

Developmentalists who use the operant learning paradigm (Peláez-Nogueras & Gewirtz, 1997) have been clear in that a stimulus that functions as discriminative for a particular response in a given context need not function as an $S^D$ for a different response in the same context for the same response in a different context or for the same response of a different person in the same or a different context. An organism's responses are functionally related to the controlling stimuli. No comprehensive empirical account of the causes of behavior development can be attained if the functional relations between stimuli, responses, and contextual variables are not delineated.

Increasing evidence shows that the effectiveness and the function of a stimulus in controlling an individual's behavior (by evoking/discriminative and reinforcing functions) depends upon the *contextual interacting variables*, including the current and historical, organismic/biological and environmental/ecological variables discussed in this paper.

### *Linear Causality versus Nonlinear Interactionism*

The typical view of causality in mother-child studies, particularly in controlled laboratory experiments, has been linear. Linear causality models (e.g., Rapoport, 1968) and traditional research methods have defined causality in terms of a linear relationship between antecedent stimuli, behavior, and consequent events. The concept of causality, as reflected in classical deterministic and mechanistic models, represents problems for understanding behavior development and its dynamic nature. An understanding more consistent with a dynamic systems model requires an analysis of the interdependence between this three-term contingency and the interrelated contextual variables participating. This type of analysis presents a major challenge because the many contextual variables involved can create multiple patterns of functional relations in the antecedent discriminative and reinforcing stimuli operating. The existing traditional methods in basic and applied research ordinarily do not take these multiple interrelated influences into account.

There has been interest in determining whether the behavior of the mother provides the proximal causes of the behavior of the child (see Gewirtz & Peláez-Nogueras, 1992b for a review of operant learning studies in infancy). At other times, it has been asked whether the behavior of the child is a proximal cause of the mother's behavior (Gewirtz & Boyd, 1977). More recently, it has been shown in research analyzes that the behavior of the mother and the behavior of the child function not only as concurrent influences on each other, but also as functions of the contextual conditions within which these behaviors are embedded (e.g., Peláez Nogueras, 1989). The cause of the behavior change depends on the multiple interacting variables. The goal is to expand behavior-analytic methods by moving into both descriptive and functional analyses of the contextual determinants of behavior.

## Strong Effects of Interacting Contextual Variables

In addition to altering the efficacy of discriminative and reinforcing stimuli, the contextual variables also determine the functionality (and directionality) of stimulus effects (e.g., whether a stimulus functions as positive reinforcer or punisher). Hence, contextual variables not only inflect behavior and the various antecedent and concurrent variables (e.g., inhibitory and facilitatory mechanisms), but also affect the interplay between reciprocal interactions among stimuli and response functions in context. Because contextual variables interact reciprocally with behavior, these variables can be seen to alter the functional relations within the three-term contingency. Indeed, the probability of behavior change at any given moment, even within a narrow segment of the life span, may vary as a function of diverse contextual conditions.

Numerous researchers have dealt with these variables under different headings: "third variables" (Skinner, 1931), "setting factors" (Kantor, 1946), "setting events" (Bijou & Baer, 1978; Bijou, 1996), "state" and "potentiating" variables (Goldiamond & Dyrud, 1967), "contextual determinants" (Gewirtz, 1972; Morris, 1988; Peláez-Nogueras & Gewirtz, 1997), and "establishing operations" (Michael, 1982, 1993). But rather than take context as a source of variation and hold it constant--which has been the typical research method within behavior analysis--the historical and current context should be a subject matter for experimental analysis (Morris, 1988, 1992). Knowledge of phylogenic history (i.e., species-typic boundaries and preparedness in biological structure/vulnerability and behavioral function) and ontogenic historical causation (individual-typic boundaries and preparedness in biological and behavioral form and function, and variability in both) is fundamental for a complete behavior-analytic research strategy. The structure of the current context involves the biological organism (i.e., the child's anatomy and physiology), the environment (physical ecology), and the changes and variability in both. The function of the current context can potentiate or actualize the functions of stimuli and responses. The function of contextual variables for stimuli and responses involves the analysis of variables such as deprivation, illness, fatigue, drug effects, and history of reinforcement, among many others.

### *Contextual Variables as "Interactants"*

As mentioned in the introduction, the contextual variables that have been emphasized are not restricted to static boundary or initial conditions; they are "interactants," to borrow a term from Oyama (1985). It is preferred by the author to have preferred to use the term contextual interactants to stand generically for all developmentally-relevant factors over other terms such as "setting factors," "setting events," "establishing operations," "potentiating variables," and "third variables," because it has not always been clear what these other terms were intended to encompass (Peláez-Nogueras & Gewirtz, 1997). Even so, one should be cautions because all such terms may carry considerable explanatory burden in an interpretive account (Marr, 1993). For this reason, I restrict the usage of contextual interactants to the identities of fundamental classes of variables that interact with the behavior of the organism and with the discriminative and reinforcing contingencies that control it.

The study of "context" is challenging because context should not be limited to those conditions that influence the effects of reinforcing stimuli, such as motivational variables (e.g., deprivation), or establishing operations (Keller & Schoenfeld, 1950). Nor should studies be limited to controlling the boundary or initial/static conditions in the test chamber (e.g., temperature, or light). The effects of the contextual interactants need to go beyond variables that have momentary effects. That is, these variables are not static in natural environments, and thus should not be kept constant by the researcher. Furthermore, they are continuously interacting with the organism's behavior as well as with other environmental variables, and therefore are interdependent.

Although behavior analytic research for many years has been capable of predicting and controlling behavior without knowledge of the roles of contextual interactants, such research has been limited to behavior that is highly stable and mostly under laboratory conditions. Such research may fail to contribute to the understanding of complex dynamic human interactions. In human behavioral development, it is precisely the multidirectionality of behavior and its variability, within and between individuals, which are the phenomena of interest. Behavior that shows stability may be easy to predict, but behavior with variability is often not well understood and is difficult to predict.

### *Context in the Study of Dyadic Interactions*

If contextual determinants of behavior are to be investigated, some departures from and expansions of the traditional behavior-analytical methodologies may be necessary. For instance, Wahler and Fox (1981) have proposed that behavior-analytic methodology should focus on at least three features: a) the measurement unit (global entities monitored through molar units of measurement), b) the temporal relations among the unit of study (where we should have no a priori assumptions about "ideal" or necessary time spans between relevant contextual variables interacting and the particular behavior under study), and c) the mode of analysis (alternative methods to the experimental analysis, like descriptive and correlational methods). Their program of research suggests ways of studying contextual variables in applied behavior analysis.

### *Understanding Dyadic Interactions*

For the behavior-analytic researchers studying human dyads (pairs), it is axiomatic that a response of one of two actors (A) that routinely follows a recurring response of the other actor (B), can constitute a reinforcement contingency for actor B's response if it increases systematically in rate. Similarly, the increase in B's rate of responding may also function as a reinforcer for A's response and A's response will also increase in rate. Thus, one feature of the dyadic interaction is the potential bidirectionality of reinforcement effects--each actor's behavior is influenced by the behavior of the other. However, a problem in the study of spontaneous dyadic interactions, for instance in the parent-infant case, is that the identity and topography of response elements of the set of turn-taking responses (e.g., smiles, touches, vocalizations, turning away). During these interactions, each member of the dyad can change at every turn in the series. For this reason, behavior analytic researchers who have tried to study the effects of reinforcement contingencies on dyadic behavior have missed the flow of influence in such interaction sequences because one of the variables is held constant. For example, in mother-infant dyadic interactions the turn-taking response of one dyad member (typically the mother) is controlled or manipulated, while the infant's response that provides the dependent variable is left free to vary (e.g., Gewirtz & Peláez-Nogueras, 1991, 1992a; Peláez-Nogueras, 1989; 1992; Peláez-Nogueras et al., 1996a; 1996b; Poulson, 1983).

Recently, however, operant developmentalists have begun to analyze infant-mother interactions in natural interaction settings without the use of a limiting experimental procedure as above. For example, the behavior analyst may record the behavior-unit elements of each of the two interactors in sequence and then search for conditional relations between adult behavior elements at different turn positions (sequential lags) for each infant behavior of interest (e.g., Haupt & Gewirtz, 1968; Patterson & Moore, 1979). By observing the conditional probabilities in sequential-lag analysis, the researcher can examine the impact of presumptive reinforcement contingencies for each infant target response under ecologically valid circumstances while taking contextual variables into consideration (e.g., stratifying for contextual functions).

### *Attempts at Studying Multiple Interactions*

There are several models for studying multiple interactions. For instance, contingency frequency analysis is a data-analytic model that attempts to analyze patterns of multiple interactions in causal fields (von Eye, 1990). The lag-sequential model analyzes the contingency and cyclicity in behavioral interaction (Sackett, 1979). Even so, these tools for identifying *functional* relations among large numbers of responses in interaction still pose difficult problems. The method of sequential analysis of dyadic responses is not optimally conducive to translating the contingencies implied into reinforcement effects. This is because at every turn in the interaction sequence, there could be different behavior combinations emitted by a dyad member, different numbers of responses can occur concurrently, and/or a particular dyad member's behavior might occur intermittently or infrequently. Thus, the behavior-analytic model may have difficulty isolating the functional relations involved. In the past, these complications led many behavior researchers to study the flow of influence in two-way parent-infant interaction in experimentally contrived settings, in which the responses of one member of the dyad are controlled.

Kantor (1924) originally distinguished between organismic and environmental setting factors and placed "immediacy" as a temporal restriction on the effects of setting factors. Morris (1992), however, emphasized that the distinction between historical and current context is necessary and should not be defined temporally or structurally. Rather, he suggested a functional distinction between current and historical context based on effects: "The historical context established what behavior may occur, as a disposition, whereas the current context enables what behaviors can occur and, if it can occur... whether the functional relations will be actualized" (p. 7).

### *Classification of Contextual Interactants*

A taxonomy of current and historical, phylogenic and ontogenic, biological-organismic and environmental-ecological contextual variables, in terms of form and function of context has been outlined in detailed by Morris (1992). Earlier behavior analysts provided a classification of contextual qualifiers (Gewirtz, 1972), setting events (Bijou & Baer, 1978; Bijou, 1996), and establishing operations (Michael, 1982). In what follows, I will elaborate on these contextual taxonomies while highlighting several studies, mainly from the infancy literature, that will illustrate the function of the contextual variables.

Contextual variables may operate either concurrently with or preceding the stimulus-response interaction under study. Thus, they can be classified into two main categories: historical and contemporaneous (Gewirtz, 1972; Morris 1992). These two can be ordered along several dimensions, some which inevitably overlap. Historical contextual interactants can be readily interpretable as outcomes of learning (e.g., history of respondent and operant conditioning, habituation). The concept of contextual variables also includes such antecedent conditions as previous stimulus-response interactions. To study the "act in context" also means the study of the historical context that includes the individual's earlier learning experiences (i.e., history of conditioning). This history of behavior and contingencies is certain to influence the functional relations among stimuli and responses in subsequent interactions. These historical variables (that I call here interactants) thereby can affect the reinforcing contingencies that will be effective for behavior and developmental change (e.g., Wanchisen & Tatham, 1991). The conditioned value of a particular reinforcer source is one example.

Contemporaneous contextual interactants that heighten stimulus saliency for the most part do not appear to be established through learning (e.g., deprivation-satiation context for a stimulus ground that contrasts with a stimulus figure). Typically these are variables associated with a person's biological, physiological or organismic characteristics (e.g., genes, physical characteristic, organ functions), and organismic constraints such as fatigue, deprivation, illness, drug, hormonal changes) determine the efficacy and function of discriminative and reinforcing/punishing stimuli.

These biological variables both influence and, reciprocally, are influenced by discriminative and reinforcing stimuli.

## Research Examples with Infants and their Mothers

In early interventions (Peláez-Nogueras, Field, Cigales, Gonzalez, & Clasky, 1994) depressed mothers who were *withdrawn* and unresponsive to their infants' cue, were trained to use an attention-getting procedure to elicit/evoke, and to respond contingently to, their infants' initiations of given behaviors. On the other hand, depressed mothers who were *intrusive* and overstimulating were trained to decrease the amount and degree of stimulation and the contingencies they provide their infants via imitation (Malphurs et al., 1996).

Under both procedures, mothers learned to regulate their behavior and also to detect the behavioral cues that their infants emit during the interaction. One such cue for the mother was the infant's state of arousal from deep sleep, to active alert, to high arousal as assessed by the Carolina Record of Individual Behavior, or the Brazelton Neonatal Behavior Assessment (Brazelton, 1973). If a mother initiated an action when the infant is at either end of the arousal continuum, the infant would likely not respond positively. A mother can readily detect these states following training. Hence, the infant's state of arousal is an intrachild variable denoted by the infant's overt actions that set the context for the next interaction. But more important to the theme of this article, the infant's state of arousal may change during the interaction and a well trained mother adjusts the quality, timing, and intensity of the stimulation provided. The interaction is a dynamic ever-changing process, and to determine whether training for the mother is effective, it is important to record whether the mother's behavior changes systematically with changes in the infant's behavior. This is difficult to demonstrate if the infant's behavior is held constant.

### *Prenatal Experience as Determinant of Later Preferences*

One example of a contextual interactant is that earlier experience determines stimulus efficacy on later operant learning. This point can be illustrated by the work of DeCasper and associates, who demonstrated the impact of systematic prenatal auditory exposure on postnatal operant conditioning (e.g., DeCasper & Fifer, 1980; DeCasper & Prescott, 1984; DeCasper & Spence, 1986). In the DeCasper studies, human newborns exhibited increased nonnutritive sucking to produce the acoustic properties of a speech passage their mothers had recited repeatedly during the last trimester of gestation, compared to a passage their mothers had not recited--i.e., they preferred the maternal passage (DeCasper & Spence, 1986). Also, the maternal voice, to which the fetus was exposed during gestation, was found to function as a more effective reinforcer for the newborn (as evidenced by high sucking response rates) than did a stranger's voice, to which the infant was never exposed (Spence & DeCasper, 1987). These studies indicate how in-utero auditory experience can affect postnatal behavior and learning.

### *Learning to Reference in Unknown Contexts*

In the area of infant socio-emotional development, infant social referencing in ambiguous contexts (i.e., infant behaviors being cued by maternal facial expressions) and subsequent behavior can result from operant learning generated by positive and aversive contingencies for differentially cued infant behavior in those ambiguous contexts. For example, Gewirtz and Peláez-Nogueras (1992a) showed that maternal facial response-cues need not be limited to those providing affective or emotional information to their infants, such as those of joy and fear, as proposed by Campos (1983). Nine-month-old infants learned to socially reference nonsense, originally arbitrary, maternal expressions. The results of that study suggest that the extent to which an infant turns to search its mother's face for discriminative expressive cues in contexts of uncertainty depends on success in obtaining such information, its validity, and its utility in such a context.

### *The Role of Context in the Initial Formation of Attachments*

Two experiments conducted in our laboratory to study mother-infant attachment (Gewirtz & Peláez-Nogueras, 1991; Peláez-Nogueras, 1989) demonstrated how infant protests can come under the close control of discriminative stimuli and reinforcement contingencies generated by a mother's behaviors in different contexts. The infants' protests were conditioned in two *contexts*: during maternal departures and during brief maternal separations from the child. By changing the cues and contingencies provided by the mother in the two contexts (departure and separation), we were able to demonstrate that infants learned to respond differentially to maternal departures and separations, in addition to maternal cues and contingencies. That is, in one condition their protests were conditioned during their mothers' departures, and they learned a behavior as an alternative to protest immediately after the separation occurred. In the second condition, the infants learned the inverse relation of protests to context: that is, to play with their toys during maternal departures and not to protest to her "goodbye" cues, while protesting immediately after she left the room (separations). Those two conditions showed that such infant protests can be differentially shaped by patterns of contingent maternal cues and contingencies in two distinct settings. They also provide evidence for the conditioned basis of the separation protests that, in the developmental literature, have served as indices of attachment for Schaffer and Emerson (1964), as denoting security or insecurity of "attachment" for Ainsworth and Wittig (1969), and as index of "separation anxiety" for Kagan, Kearsley, and Zelazo (1978).

In sum, a behavior-analytic approach to development calls for an analysis of stimulus structure and functions, response structure and functions, their interchange at a particular point, and the sequences of such interactions across successive moments. Behavior analysts should be interested not only in the principles responsible for the changes observed in behavior, but also in the different directions, speeds, and contingency arrangements that result from the behavior-environment interchanges, and on determining how the contextual variables alter these interactions. The operant learning paradigm provides a valuable model for the study of infant (indeed all human) development, if only to determine which behavior change denoting development could, and which could not, be susceptible to learning operations. Thus, learning operations can focus those contextual/environmental factors that can inflect the course of human development.

### *Contextual Interactants can Change Stimulus Function*

As the infant behavior repertoire increases and becomes more complex (due to maturational/organismic processes and changes in socialization practices), some of these potential discriminative and reinforcing stimuli may drop out functionally to be superseded by others, or their relative ability to function as reinforcers may change. The nature of the event patterns constituting the discriminative and reinforcing properties of certain stimuli change as the infant physically matures and moves from one capacity level to a higher one. For example, the social (and very likely conditioned) stimulus of attention produced by the parent may be superseded in salience by that of verbal approval provided by parents for successively more complex performances. This occurs in restricted settings in which the parent's cues (e.g., as denoted by smiles) signal the delivery of most of the array of important reinforcing stimuli for the child. A developmental analysis of infant behavior, for example, would examine changes in the efficacy of discriminative and reinforcing stimuli for diverse infant behaviors, considering changes in the infant's receptor and effector capacities due to early neonatal stimulus response interactions.

### *A Comment on Research Methods*

To behavior analysts who rely only on experimentation to understand functional behavior-environment relations, the results of interpretive methods might seem speculative and subjective. Knowledge obtained from experimentation, however, is no different from any other knowledge. This is because results from experimental methods require as much interpretation as any other kind of data (Dougher, 1993). Whether using interpretive, narrative or descriptive methodologies, new research techniques that focus on understanding the relation between behavior and its contexts seem consistent and could be exercised within behavior analysis. Descriptive and interpretive methods allow us to identify variables that predict behavior and that can later be used in a functional analysis.

## Conclusion

I have emphasized that both contingencies and contextual interactants are primary causes of behavior development. Consequently, the probability of an individual learning at a given developmental point will vary not only as a function of reinforcing stimuli (or punishers), but also as a function of the historical and contemporaneous contextual variables interacting (or participating).

The study of the contextual interactants may help behavior analysts interested in human development to explain the multidirectionality of behavior development, intraindividual variability, and interindividual differences. Moreover, identifying and when possible manipulating these variables is indispensable for a proper analysis of the effects of stimulus control on behavior change. By identifying these variables in our descriptive analyses or including them in our subsequent functional analysis (by controlling reinforcing contingencies and manipulating context), or by conducting frequency analyses, sequential analyses, and other methods, we may be able to better understand and predict behavior change and to explain behavior variability. Furthermore, we may work more successfully with existing data and generate new information about human behavior, constituting information that would lead us to a greater understanding of human behavioral development than has been achieved thus far.

Perhaps the change and growth that has taken place in behavior analysis of human development within the last decade suggests that behavior-analytic theory may be undergoing a paradigm shift. I take a risk and say that it may be moving to a new stage of behavior analysis: a stage with adventurous researchers who wish to contribute toward solving everyday practical problems and towards a greater understanding of human interactions in context.

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# A Commentary on Development: SD's and EO's

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*We should beware of operational redefinitions of mentalistic, reified terms, and connotationally loaded terms, like behavioral development. And we should beware of confusions between $S^D$s and EOs.*

## Development

Here's the problem with operational redefinitions of mentalistic and reified terms: The original meaning of those terms still controls most of the behavior of most of the users, in spite of the operational redefinition. For example, psychologists can operationally redefine *intelligence* as *what is measured on an intelligence test* as often and as loudly as they want; but within 10 seconds of that definition, the audience and even the psychologists themselves are responding as if intelligence were an innate, inner cause of intelligent behavior and, not incidentally, of their own personal success.

I have a similar concern with the common definition of behavioral development as *progressive changes in environment-behavior relationships.* While this definition is nominally neutral as to etiology of those changes, the context tends to imply biological determinism, as in the following common biological definition of *development*—*a purely biological unfolding of events involved in an organism changing gradually from a simple to a more complex level.* I don't think we can define out that connotation.

I would prefer to reload the dice with some such term as *behavioral acquisition* or the *acquisition of a behavioral repertoire progressive changes in environment - behavior relations,* though perhaps without progressive (http://www.dict.org/bin/Dict). However, I shan't hold my breath until ABA adopts this terminological reform.

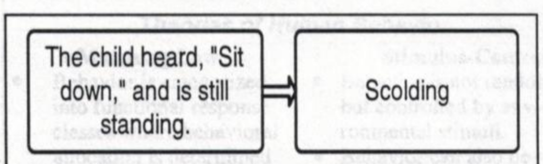
### *The SD vs. the Warning Stimulus*

Schlinger (on this volume) discusses the parent's command, "Sit down." Now, even though an analysis of "Sit down" is tangential to Schlinger's paper, and even though his example may not even be in the published version, I became intrigued with it and would like to share my intrigue with you.

At first, I went along with the standard assumption that "Sit down" was an $S^D$ for the response of sitting down. But that did not seem to fit. In the presence of an $S^D$, a response will more likely be reinforced or punished. Does that fit here? Surely not punishment, so what about reinforcement? The parent says, "Sit down," the child sits down, and the parent says, "Good sitting behavior, child." Only in behavior-analytic textbooks would that happen. In the real world, at least the one I am a member of, such compliance is not praised and certainly doesn't get an M&M. So, if this is not a reinforcement contingency, what is it? Avoidance.

To understand this avoidance analysis, we need to look at a conditional stimulus—the stimuli arising from the parent's having just said, "Sit down," combined with or conditional on child's standing. This conditional stimulus, instruction combined with noncompliance, is a learned aversive condition because it has been paired with some sort of aversive condition such as frowns, scoldings, shouts, or hits (Figure 1).

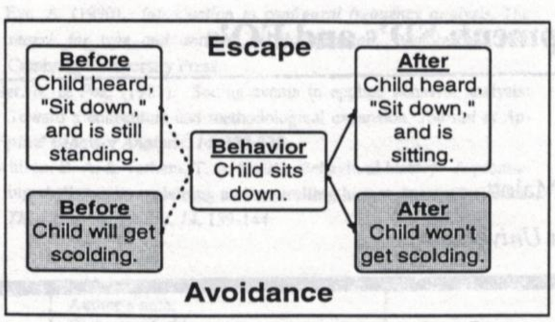
Figure 1. A pairing procedure that results in a learned aversive stimulus or condition.




Neither standing by itself nor having just heard, "Sit down," is an aversive condition; only the combination of the two stimuli is aversive. So, if the child sits down, he or she will escape the learned aversive condition, the conditional stimulus. The child will still have just heard "Sit down" but won't be standing, so the child will no longer be in an aversive condition (see the top contingency in Figure 2).

Furthermore, if the child immediately sits down, he or she will also avoid the aversive condition of being scolded, etc.—an avoidance contingency.

Figure 2. A two-factor escape/avoidance contingency.




**In sum, I suggest that "Sit down" and probably most other parental instructions are not $S^D$s, but rather they are warning stimuli or reflexive establishing operations (EOs) that form a crucial part of a two-factor escape/avoidance contingency. Incidentally, I think the use of the term "antecedent" increases the frequency with which behavior analysts fail to make the important distinction between $S^D$s and EOs. At the end of rants such as this, it is appropriate to append -of course, this is just my opinion, and I may be wrong; but I am probably not.**

# Understanding Behavioral Escalation: From Theory to Practice

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*This article describes various theoretical structures that guide our understanding of behavior escalation. The conceptual and applied aspects of the article make it a timely tribute to the scholarship of the late Donald Baer, father of behavior analysis. Since the seminal article by Donald Baer and his colleagues on Some Current Dimensions of Applied Behavior Analysis (1968), educators and practitioners have strived for a better understanding the applications of behavior analysis and social validity of behavioral interventions for sustained effects. In keeping with most of Donald Baer's contributions to this field, this article is a dedication to his principles, beliefs and practice.*

## Understanding Behavioral Escalation: From Theory to Practice

In school settings, students with severe behavioral problems present tremendous challenges even to the most experienced classroom teachers (Carr, Taylor, & Robinson, 1991). In the event of a behavioral escalation, instruction comes to a standstill, the teacher and student become engaged in a confrontational dialogue, and other students in class become anxious or curious spectators. What appears to be particularly challenging is that teachers may not always be able to *predict* the precise moment in time when escalation will occur because they may not have a good *understanding* of the behavioral pattern. It is common knowledge that understanding and predicting behavioral patterns are precursors for *controlling* events of escalation (Baer, Wolf, & Risley, 1968; Vargas, 1977). This article provides an operational definition of behavioral escalation and describes the underlying theoretical framework. Embedded within the theoretical framework are various empirically effective strategies for preventing and managing behavioral escalation.

### *Behavioral Escalation Defined*

Behavioral escalation is defined as an event where a class of topographically different responses occur in a sequential pattern in which successive responses are of increasing severity or intensity (Albin, O'Brien, & Horner, 1992; Colvin, 1990; Lagerspetz, 1964; Strain & Ezzel, 1978; Wahler & Fox, 1982). Such sequences usually begin with less severe topographies (e.g., complaining and arguing) and end with more severe responses (e.g., physical assault) that cause injury to people and/or damage and property (Patterson, 1982; Shukla, 1994). The various responses that form an escalating sequence are members of the same functional response class. In other words, they are maintained by the same behavioral function, for example, to escape an unpreferred activity or person or to access a preferred object (Shukla & Albin, 1995; Sprague & Horner, 1992). Preventing or managing behavioral escalation necessitates a conceptual understanding of the pattern and the laws that govern their occurrence. The next section describes the theoretical models that provide a better understanding of escalating response sequences.

### *Theoretical Framework for Understanding Behavioral Escalation*

Behavioral escalation can be comprehended from the perspective of two interrelated theories of human behavior, that is, the matching law and stimulus control.

***Theories of Human Behavior***

| **Matching Law** | **Stimulus-Control** |
| --- | --- |
| • Behavior is categorized into functional response classes where behavioral allocation is determined by response efficiency.<br>• A functionally equivalent alternate communicative response is necessary to replace problem behavior. | • Behavior is not random but controlled by environmental stimuli.<br>• Behavior can also be controlled by one's own previous response.<br>• Establishing operations increase or decrease the value of reinforcers, thus affecting behavioral allocation. |

The *matching law* states that all organisms choose to engage in specific responses out of a class of concurrently available alternatives at any given moment in time, depending upon the schedule of reinforcement associated with each of the topographies within the context (Bernstein & Ebbesen, 1978; Borrero & Vollmer, 2002; Herrnstein, 1961; Mace, McCurdy, & Quigley, 1990). The application of this law is best understood within the context of functional response classes (e.g., Martens & Houk, 1989) and functional equivalence (Baer, 1982; Carr & Durand, 1985a; Lalli, Casey, & Kates, 1995). Because the various members of a response class are controlled by socially mediated environmental stimuli (Baer, 1997; Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991; Peláez-Nogueras & Gewirtz, 1997; Rogers-Warren & Baer, 1976) or one's own previous response (Grote, Rosales, & Baer, 1996), the stimulus-control theory cannot be disassociated from the matching law theory for understanding the structural organization of response patterns that lead to behavioral escalation.

## Role of Response Classes in Behavioral Support

A response class is a group of topographically different responses (e.g., pushing, screaming, throwing objects) that are emitted to produce a common functional effect (e.g., escape from task, attention from peers, internal stimulation) (Barrett, Johnston, & Pennypacker, 1986; Carr, 1988; Johnston & Pennypacker, 1980; Parrish, Cataldo, Kolko, Neef, & Egel, 1986). Of the different behaviors that form a response class, some may occur more frequently than others (e.g., leaving one's assigned seat may occur more frequently than hitting the teacher) (Lalli, Mace, Wohn, & Livezey, 1995; Sevin, Gulotta, Sierp, Rosica, & Miller, 2002). Research has also demonstrated that if one member of the response class is manipulated by ignoring, blocking or punishing, it changes the probability of occurrence of other members in the response class either in frequency or intensity (Lerman & Iwata, 1996; Parrish et al., 1986; Sevin et al., 2002; Shukla & Albin, 1995; Sprague & Horner, 1992). When one behavior from a response class is suppressed, the next most probable behavior to produce the maintaining consequence from the same class of responses is likely to be performed at a higher rate than baseline levels (Goh & Iwata, 1994).

The response class theory points to the need for understanding how behaviors become members of a class of responses. It appears that as new responses are learned, a behavior hierarchy is established (Baer, 1982; Baer, 1986; Fuqua, 1984). It is also important to understand which variables determine which member of a response class will be performed under any specific situation (Baer, 1997). Certain environmental events will occasion the occurrence of either adaptive or less severe responses while others will occasion the occurrence of more severe responses. In fact, if less severe or adaptive responses produce new and preferred outcomes, the new contingencies will be associated with "even more far-reaching consequences," creating behavioral cusps (Rosales-Ruiz & Baer, 1997, p. 533). Therefore, it stands to reason that if a functionally equivalent alternative response is taught and maintained initially at high rates of reinforcement, the new response will occur at higher rates, making problem behavior inefficient and ineffective (Carr & Durand, 1985; Day, Horner, & O'Neill, 1994; Durand & Carr, 1992; Jayne, Schloss, Alper, & Menscher, 1994; Lalli et al., 1995). Teaching a functionally equivalent response, then, needs to be the focus of behavioral interventions if assessment of social validity is the over-arching goal (Schwartz & Baer, 1991).

The functional equivalence theory has empirical roots in the logic that problem behavior serves communicative functions for the person who engages in such behavior (Carr & Durand, 1985b; Kennedy, Meyer, Knowles, & Shukla, 2000). It suggests that if problem behaviors have communicative functions, we need to identify a class of responses so that a single intervention (e.g., functional communication training) could effectively decrease all problem behavior (Derby et al., 1997; Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991). Multiple problem behaviors that form a single functional response class seem to be organized in various kinds of patterns that appear to be structurally different from each other. The next section provides a review of different response patterns described in the literature.

### *Organization of Response Structures*

The literature has described different underlying variables in explaining response patterns that comprise of multiple behaviors that occur one after the other. Terms used in the literature include operant chains (Baer, 1982; Skinner, 1938), response sequences (Evans, Meyer, Kurkjian, & Kishi, 1988), escalating sequences (Colvin, 1990; Walker, Colvin, & Ramsey, 1995), and behavior hierarchies (Baer, 1982), with each pattern being structurally different from the other.

***Operant chains.*** Skinner (1938) described an operant chain as "The response of one reflex [that] constitute[s] or produce[s] the eliciting or discriminative stimulus of another" (p. 32). Established as the "Law of Chaining," it emphasizes the stimulus-control relationship in an operant chain where one behavior immediately follows another (Baer, 1982; Millenson & Leslie, 1979; Rusch, Rose, & Greenwood, 1988). In other words, the previous response acts as a discriminative stimulus for the next response, producing an operant chain (Wolf, Risley, & Mees, 1964). A behavioral chain is likely to have a high degree of consistency in the steps of the sequence such that early behaviors can reliably predict the occurrence of later behaviors (Baer, 1997; Evans et al., 1988). A good example of an operant response chain might include doing specific tasks within activity routines that involve a series of behaviors learned in a sequence, e.g., brushing one's teeth. Sometimes problem behaviors also seem to occur as operant chains. An example might include a pattern where one problem behavior clearly serves as a discriminative stimulus for the next response (see Figure 1).

***Response sequences.*** A response sequence is structurally different from an operant chain and more difficult to explain (Evans et al., 1988; Voeltz & Evans, 1982). In a response sequence, early behaviors do *not* act as discriminative stimuli for subsequent responses but *increase the probability*

*Figure 1. An operant chain of problematic responses triggered initially by the teacher behavior but is maintained by the student's own response (i.e., a response-response chain) until a functional reinforcer is produced.*

| Discriminative Stimulus ($S^d$) 1 | Response (R) 1 |
|---|---|
| Teacher: Start your work, Jason. This needs to be completed before you can go to recess. (Teacher attends to other students.) | Jason: Why do we have to do this now? Shakes his head. (Whining and shaking head) |
| Consequence / $S^d$ 2<br>Whining and shaking head | *R 2*<br>Jason: This is boring. I hate such things. (Complaining) |
| Consequence / $S^d$ 3<br>Complaining | *R 3*<br>Jason: I can't do this crap! You can't make me! (Screaming) |
| | Teacher gives a time-out. (Functional reinforcer - escape from task) |

of occurrence of the next response sometime in the proximal future (Evans et al., 1988; Voeltz & Evans, 1982). The sequence is likely to involve other responses from a class of responses until one is successful in producing a functional reinforcer (Duarte, Svein, Rosales-Ruiz, & Baer, 1998). The previous response in a sequence makes the later response more likely and hence predictable to a certain extent, e.g., pushing task materials away increases the probability that student might throw task materials if the previous response fails to produce a functional reinforcer (Shukla & Albin, 1995). However, it is also likely that the student will not throw task materials but hit the teacher. The two subsequent responses do not appear to be inherently organized in some form of a structural pattern as is evident in an operant chain (Evans et al., 1988), but are determined by the history of specific responses in producing a functional reinforcer (see Figure 2). Thus, one of the determinants of response efficiency is one's history with schedules of reinforcement (Baer, 1982; Carr, Bailey, Ecott, Lucker, & Weil, 1998; Duarte, Svein, Rosales-Ruiz, & Baer, 1998).

***Escalating sequences***. This pattern is structurally similar to response sequences described above, except that each subsequent response is more serious or severe compared to the previous one (Albin, O'Brien, & Horner, 1992; Colvin, 1990; Lagerspetz, 1964; Loeber, et al., 1993; Patterson, 1982). A content review on escalating sequences reveals that behaviorists have described this term differentially. Researchers in laboratory settings who studied animal aggression have stated behavioral escalations to be a result of externally induced stimuli. Studies indicate that trained fighting mice very rapidly escalated in intensity when placed with other trained fighting mice (Lagerspetz, 1964). The intensity of the victim's reaction to the attack correlated with the likelihood of higher intensities during future attacks except in cases where the victim was nonreactive or drugged, in which case the attacks did not occur (Knutson & Hyman, 1973).

*Figure 2. A response sequence in which history of reinforcement for specific members of a functional response class determine behavioral allocation.*

| Discriminative Stimulus ($S^d$) 1 | Response (R) 1 | Response Alternatives and Related History of Consequences |
|---|---|---|
| Teacher: Did you bring your homework, Kanisha? | Kanisha: I need to speak with you. | • If "Yes" then teacher will ask to show homework<br>• If "No" then teacher will take away a privilege<br>• If "I need to speak with you," then teacher will have a private conversation |
| Consequence / $S^d$2<br>Teacher: What's the matter, Kanisha? Did you forget your homework? | *R 2*<br>Kanisha: Why are you always on my case? | • If "Yes" then teacher will insult in front of peers<br>• If "No" then teacher will ask to show homework<br>• If "Why are you always on my case?" then teacher will give a time-out. |
| Consequence / $S^d$3<br>Teacher: I know when you are not telling me the truth. Show me your homework. | R 3<br>Kanisha: I will tell on you that you keep harassing me! | • Previous adaptive response did not produce functional reinforcer.<br>• Need to escape request intensifies.<br>• Use of past experience to access functional reinforcer. |
| Consequence / $S^d$4<br>Teacher: Well, I will send you to the Principal for insubordination!" | *R 4*<br>Kanisha: Stops arguing with teacher. | • Previous history strengthened. (Functional reinforcer - escape from aversive request produced by arguing.) |

Researchers in the field of conduct disorders define the sequential nature of behavioral escalation from a developmental perspective. Findings from a longitudinal study by Loeber and colleagues (1993) indicated that disruptive behaviors in boys with antisocial behavior tended to follow a systematic developmental sequence showing a gradual unfolding of problem behaviors. The behavioral sequence started with stubborn behavior, followed by minor covert behavior, defiance, aggression, and property damage, the age of onset for early behaviors being 10 years. The moderate and serious delinquency, authority avoidance, fighting, and violence all shared a median age of onset at age 13. This sequential pattern, however, may be viewed as a "developmental pathway" (Costello & Angold, 1993; Reid, 1993) rather than as a response sequence emitted by specific discriminative stimuli and controlled by specific maintaining reinforcers that operate within a single behavioral episode. The literature in the area of conduct disorders emphasizes the coercive nature of interactions where both players escalate together in a fairly predictable sequence (Colvin, 1990; Kazdin, 1987; Patterson, 1982; Patterson, Reid, & Dishion, 1992; Walker, 1993). In other words, one person's response emits a more severe reaction in the other person to a point where both persons engage in progressively severe responses (Wahler & Dumas, 1986). The sequence culminates with a dangerous behavior on the part of one person (e.g., physical assault). This pattern of interaction basically operates on a negative reinforcement paradigm (Colvin, 1990; Patterson, 1982). When an aversive stimulus (e.g., teacher correction) is removed following display of a dangerous behavior (e.g., physical assault), the immediate outcome is that the dangerous behavior stops occurring. This serves to reinforce both players (see Figure 3). In fact, the teacher or parent's behavior often provides clues regarding the function of student behavioral problems (Taylor & Romanczyk, 1994). However, if one person avoids being drawn into the coercive interaction by remaining uninvolved or ignoring the previous response, the next response is less likely to be less severe in intensity and impact.

***Behavior hierarchies***. If we assume that both less and more severe responses are members of the same functional response class, it is logical to assume that more severe responses may occur if less severe responses are not functionally effective. Given this reasoning, it is likely that more severe responses may tend to follow less severe responses. Our clinical experiences indicate that in different stimulus contexts, the response pattern may demonstrate a different sequential order (Baer, 1982). In other words, certain contexts make some responses more probable than others (Ringdahl, Vollmer, Marcus, & Roane, 1997). From this perspective, the response class creates a hierarchy of probable responses where one response is linked to another by means of some propioceptive cues established as a result of an individual's learning history, circumstances of reinforcement or deprivation, and other motivational factors (Baer, 1982; Duarte et al., 1998; Evans et al., 1988). For example, a teacher who consistently reinforces either alternative communication or less severe problem behavior, makes more severe problem behavior irrelevant. Contrarily, if only more severe responses are reinforced (albeit inadvertently), then these will occur more frequently (Baer, 1982; Evans et al., 1988; Shukla & Albin, 1995; Voeltz & Evans, 1982) (see Figure 4).

*Figure 3. An escalating sequence of responses where each successive response is more severe in topography compared to the previous response of the same person. In such a sequence, the response of one person is a discriminative stimulus for the response of the other player; hence, both persons escalate together.*

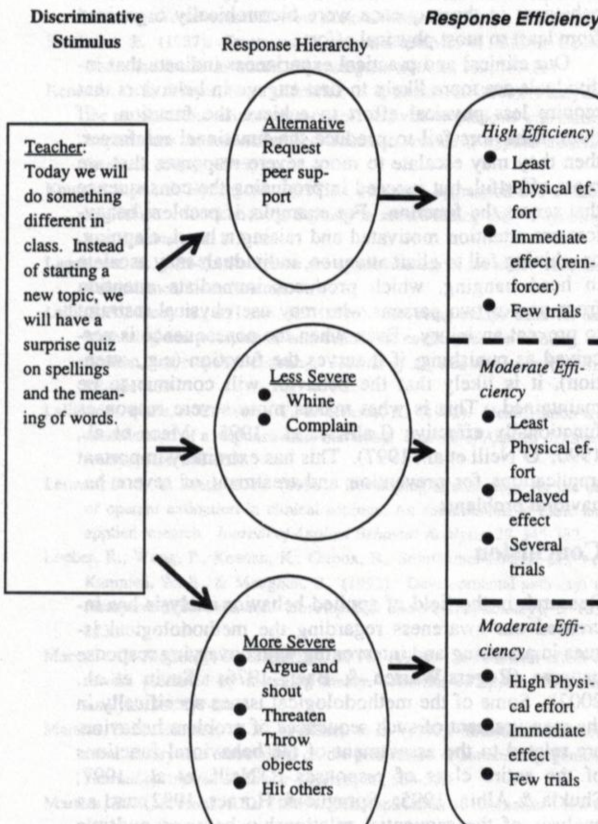
| **Discriminative Stimulus ($S^d$) 1** | <u>Response</u> **(R) 1** |
|---|---|
| <u>Teacher</u>: Ruiz, most of your problems are incorrect. You need to re-do them. | <u>Ruiz</u>: I already did them once. Why do I have to do them again? |
| **Consequence / $S^d$ 2** <u>Teacher</u>: Well, you got them all wrong. Now do them again because you're already behind the others. | *R 2* <u>Ruiz</u>: No, I am not behind! You keep finding faults with me because you don't like me! |
| **Consequence / $S^d$ 3** <u>Teacher</u>: Stop finding excuses, Ruiz. Do your problems now or else you will have to stay in class during recess. | *R 3* <u>Ruiz</u>: I won't do this crap and you can't make me! And I am not staying in here during recess. |
| **Consequence / $S^d$ 4** <u>Teacher</u>: Oh yes you are. I make the rules here not you. And if you don't start your work right now, I will have you in detention. | <u>R 4</u> **<u>Ruiz: Oh ya, let's see how. Gets up and starts walking out of the class.</u>** |
| **Consequence / $S^d$ 5** Teacher follows him, grabs his arm and tries to pull him back. | <u>R 5</u> <u>Ruiz</u>: Get your hands off me! Hits the teacher in the face and walks away from the classroom. |
| **Consequence / $S^d$ 6** Teacher calls for back-up support and leaves the student alone. | <u>R 6</u> Ruiz goes with others teachers quietly. (Functional reinforcer for student – intimidate teacher and escape difficult task. Functional reinforcer for the teacher – remove aversive student from class.) |

## Development and Expansion of Response Classes

Selection of a specific response in a behavioral hierarchy is not random. In fact, it is likely to be determined by several factors, e.g., an established reinforcement history (Baer, 1982; Evans, et al., 1988; Mace, McCurdy, & Quigley, 1990; Martens, Bradley, & Eckert, 1997), occurrence of specific establishing operations (Chandler, Fowler, & Lubeck, 1992; Horner, Day, & Day, 1997; O'Neill et al., 1997; Wahler & Fox, 1981), the physical effort it takes to perform a behavior (Baer, 1982; Friman & Poling, 1995), or the overall efficiency of the response (Horner & Day, 1991; Horner, Sprague, Brien, & Heathfield, 1990). Recent research has indicated that a new functionally equivalent response is more likely to be learned and maintained if it is more efficient than the old response (Horner & Day 1991; Horner, Sprague, O'Brien, & Heathfield, 1990; Kennedy, Meyer, Knowles, & Shukla, 2000; Shukla & Albin, 1995). These authors have documented the role of response efficiency in the context of a competing behaviors framework and functional equivalence training. Efficiency of a response is likely to be affected by the physical effort it takes to perform a given behavior, the latency for functional effect, and schedules of reinforcement (Horner & Day , 1991). If a new response requires less physical effort to perform, produces a functional outcome with little or no delay, and operates on a high schedule of reinforcement, it is more likely to be learned and maintained. For example, if a student shows a cue card to request "help" and the teacher provides immediate assistance the first time, this behavior will become more efficient compared to screaming to access teacher attention. This is because the latter appears to require more physical effort when compared to showing a card.

With specific reference to behavioral escalation, it appears that more severe responses produce the desired function with impressive speed and with fewer instances of responding compared to less severe responses (Shukla, 1994). In other words, whining or complaining can be momentarily ignored but spitting or hitting a teacher cannot be ignored in any setting. Thus, if speed of effect is important to a person, more severe responses may be a most efficient response option. However, clinical experiences indicate that individuals do not always engage in more severe responses all the time. Less severe responses tend to be performed more frequently and more severe responses less frequently (Sprague & Horner, 1992). If more severe responses were consistently more efficient for individuals, it is likely that they would engage in those behaviors more frequently, making a sequence less predictable and more difficult to manage in clinical settings. However, there is ample evidence that individuals engage in both less and more severe responses (Dunhan & Grantmyre, 1982; Shukla & Albin, 1995; Sprague & Horner, 1992).

*Figure 4. A model for determining the role of response efficiency in behavioral intervention and support. If a functionally equivalent alternative response (e.g., request peer support) is made to be more efficient, then less and more severe problem behavior will be occur at lower rates because these would be only moderately efficient.*




One logical explanation for this pattern appears to be that more severe responses require greater physical effort to perform. Even though more severe responses are more likely to produce the functional reinforcer, individuals who continue to engage in less severe responses may actually prefer to allow for delayed reinforcement than to exert great physical effort. Skinner (1938) has stated the relevance of the "law of least effort" in the selection of responses. The physical effort involved in performing a response is especially important for our understanding of more severe responses in an escalating sequence of responses. Physical effort could be viewed as the force or number of calories of energy required to perform a response (Friman & Poling, 1995; Horner & Day, 1991). More severe responses involve high physical effort (e.g., hitting is more effortful than whining). In a case study, Albin, O'Brien, and Horner (1992) did a preliminary analysis of an escalating pattern of problem behaviors to determine the role of physical effort. They used videotaped samples of the multiple responses to evaluate the amount of physical effort required for each of the behaviors in the escalating response sequence. Independent ratings of perceived effort on a scale of 1-10 by an audience naive to the purpose of the study revealed that some but not all of the behaviors in the sequence were hierarchically organized from least to most physical effort.

Our clinical and practical experiences indicate that individuals are more likely to first engage in behaviors that require less physical effort to achieve the function. If these behaviors fail to produce the functional reinforcer, then they may escalate to more severe responses that are more effortful, but succeed in producing the consequence that serves the function. For example, if problem behaviors are attention motivated and raising a hand, clapping, or whining fail to elicit attention, individuals may escalate to head banging, which produces immediate attention from one or two persons who may use physical restraint to prevent an injury. Even when the consequence is perceived as punishing, if it serves the function (e.g., attention), it is likely that the behavior will continue to be maintained. This is what makes more severe responses functionally effective (Lalli, et al., 1995; Mace et al., 1990; O'Neill et al., 1997). This has extremely important implications for prevention and treatment of severe behavioral problems.

## Conclusion

Research in the field of applied behavior analysis has increased our awareness regarding the methodological issues in assessing and intervening with covarying response patterns (Rogers-Warren & Baer, 1976; Sevin et al., 2002). Some of the methodological issues specifically in the measurement of such sequences of problem behaviors are related to the assessment of the behavioral functions of the entire class of responses (O'Neill, et al., 1997; Shukla & Albin, 1995; Sprague & Horner, 1992) and an analysis of the sequential relationship between multiple responses and their controlling variables (Bakeman & Gottman, 1986; Moran, Dumas, & Symons, 1992). From a clinical perspective, the challenge lies in utilizing the current behavioral assessment technology to identify response patterns consisting of multiple topographies of problem behavior, identifying the controlling variables, and developing positive interventions to eliminate or prevent the occurrence of more severe problem behaviors (O'Neill et al., 1997). This is a major shift in the approach to behavioral interventions for complex behavioral patterns, moving away from a focus on reducing problem behaviors toward a focus on replacing them or preventing them from occurring (Horner et al., 1990). This is a more socially valid and values-based approach (Baer, Wolf, & Risley, 1968; Carr, Robinson, Taylor, & Carlson, 1990; Schwartz & Baer, 1991; Wolf, 1978). Besides, the ability to prevent the occurrence of severe problem behaviors will enable care-providers to better support individuals with disabilities in school and community settings.

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# Relational Learning in Preverbal Infants

## *Evidence from Developmental Science*

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*This paper attempts to integrate infant cognitive development research with behavioral analytic work on stimulus and functional equivalence as a critical next step in our understanding of these processes.*

Categorization of environmental stimuli based on non-perceptual relations is a fundamental aspect of cognitive/behavioral systems (Estes, 1994; Quinn & Eimas, 1996). Such categorization entails discriminating stimulus features embedded in a compound stimulus and the ability to operate on discriminably different stimuli in a similar way. Furthermore, categorization and the ability to make non-feature-based associations between stimuli are recognized as skills associated with vocabulary and language acquisition (Gentner, 1977; Gershkoff-Stowe, Thal, Smith, & Namy, 1997; Poulin-Dubois, Graham, & Sippola, 1995; Roberts & Horowitz, 1986; Sidman, 1994; Woodward & Hoyne, 1999).

In the cognitive developmental literature, debate has arisen concerning the relative importance of *perceptually driven* versus *theory driven* processes for concept acquisition in human children (Gelman & Medin, 1993; Jones & Smith 1993a; 1993b; Keil, 1987; Mandler, 1993; Mandler & McDonough, 1993; Neisser, 1987; Newcombe, Dummey, & Lie, 1995; see also Eimas, 1994, and Gentner & Rattermann, 1991, for discussions of continuity in categorization development). This debate grew out of findings on the development of children's ability to form categories that suggested a heavy reliance on relations between stimuli (e.g., they are identical, one is larger than the other, they always occur together) rather than on the absolute properties of the stimuli (e.g., they are both blue, they both are round) as the basis of the category (Barsalou, 1987, 1993; Bower, 1989; Carey, 1985; Gelman & Markman, 1987; Gelman & O'Reilly, 1988; Greco, Hayne, & Rovee-Collier, 1990). It also follows from a long-standing interest in cognitive psychology on the distinction between relational learning and learning based on perceptual discrimination and generalization of stimulus features in category formation (e.g., Barsalou, 1999; Barsalou, Huttenlocher, & Lamberts, 1998; Gentner, 1988; Medin & Schaffer, 1978; Premack, 1983; Reese, 1968).

By the end of their first year, infants are on the verge of an explosion in categorizing behaviors, and the processes by which this occurs are under investigation (Bertin & Bhatt, 2001; Quinn & Bhatt, 2001; Rose, Futterweit, & Jankowski, 1999). This paper will suggest that the current cognitive and developmental research in this area has significant implications for behavior-analytic discussions of the phenomenon of stimulus equivalence (Sidman, 2000) and relational stimulus classes in general (Hayes, 1991), particularly discussions concerning the role of verbal behavior in forming *arbitrary* stimulus classes.

The phenomenon known as *Stimulus Equivalence* involves the formation of arbitrary stimulus classes based upon contingencies that frequently result in additional generalized conditional discriminations without the use of reinforcement or explicit instruction (see Harrison & Green, 1990; Pilgrim, Chambers, & Galizio, 1995; Saunders, Williams, & Spradlin, 1995; Smeets, 1994; Zentall, 1998). If these conditional discriminations involve reflexivity, symmetry, and transitivity, then stimulus equivalence is said to be exhibited (Dixon & Spradlin, 1976; Eikeseth & Smith, 1992; Hall & Chase, 1991; Lazar, Davis-Lang, and Sanchez, 1984; Sidman, 1986; Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982). The usual assessment of stimulus equivalence involves reinforcing responding to choice B in the presence of sample A, and choice C in the presence of sample B, using a matching-to-sample procedure with one sample and three choices. Correct matching of choices to the sample is based solely on the contingencies operating in the procedure – none of the stimuli share any absolute features that could be used to make the match. Thus, the subject produces initially blind choices that are differentially selected or reinforced (or made to be functional) (Neuringer, 1993). After consistently correct responding has been attained on the conditional discriminations trained between A and B and B and C (achieved through careful manipulation of the frequency, latency, and sequence of consequences, as well as of the order, position, and type of stimuli within and across trials), testing *without reinforcement* then occurs for the following emergent conditional discriminations: (a) A to A, B to B, C to C (identity or reflexivity); (b) B to A, C to B (symmetry); and (c) A to C (transitivity), C to A (combined symmetry and transitivity). These emergent conditional discriminations mark the formation of a class of stimuli that are related through a "goes with" relation: A "goes with" B and C.

The findings of the behavior-analytic literature on this "goes with" relation have been extended to other kinds of relations among stimuli (Hayes, 1991). For example, Hayes (1991) suggested that equivalence is one kind of relational responding and other kinds include relations of opposition, distinction, and comparison. Although there are a number of differences in the theoretical assumptions between Hayes' work and Sidman's (Sidman, 2000), these differences are germane only to the issue of the role of verbal behavior in the current discussion. Both stimulus equivalence and other forms of relational responding are said to be the product of genetic endowment and specific experience with contingencies that differentially select responding in the presence of stimuli within a class from stimuli outside of the class (Shahan & Chase, in press). Because the seminal behavior-analytic research on this topic was conducted under the rubric *stimulus equivalence*, we will use this term throughout the rest of the paper to refer to this literature and its findings.

Currently, equivalence class formation has only been observed in individuals with some degree of language ability (e.g., D'Amato, Salmon, Loukas, & Tomie, 1985; Devany, Hayes, & Nelson, 1986; Dube, McIlvane, Callahan, & Stoddard, 1993; Hayes, 1989; Lipkins, Kop, & Matthijs, 1988; Peláez, Gewirtz, Sanchez & Mahabir, 2000). This makes a certain amount of sense because equivalence relations are similar to those involved in language (Hall & Chase, 1991; Sidman, 1986), particularly semantic and word order relations, and provide a potential model of linguistic symbol systems. That is, making arbitrary "goes with" associations between stimuli that share no physical features (e.g., when a small, furry animal that barks is around, somebody emits the word *dog*), expanding classes of stimuli (e.g., relating the words *dog, pooch*, and *canine*) and arranging stimuli in novel ways (e.g., using the word *canine* in the correct word order or a sentence after learning that it is synonymous with *dog*) are precisely the tasks of a language learner. Critically, whether language mediates equivalence class formation or whether the ability to form equivalence classes underlies language acquisition is unclear (see discussion in Sidman, 2000). An understanding of the current status of cognitive research on these abilities in human infants is thus of direct relevance to the equivalence research. While most of the infant research has been conducted using the visual preferential looking paradigm (testing with novel stimuli), which involves associative, respondent learning, and the equivalence paradigm involves operant conditioning, the infant research findings suggest that the components of stimulus equivalence may be present prior to the onset of verbal behavior (see Rehfeldt & Hayes, 1998, for a discussion of the respondent-operant distinction and stimulus equivalence).

The human infant work involves demonstrations of relationally-based categorization abilities, including both transpositional relational learning (identity and other reversible relations like left-right, up-down) and arbitrary relational learning ("goes with" associations). In addition, research on human infant sensory integration skills has been conducted in this area, as the capacity for amodal relational learning (detection of an absolute feature that is shared between 2 sense modalities) may be especially important for the learning of relational as opposed to unimodal absolute feature information about objects and events in categorization.

***Sensory integration*** allows for the detection of shared *amodal* absolute features of stimuli, ones that are not unique to a given sense modality (Bahrick, 1988; 1992; 1994; 2000; 2001; Lewkowicz, 1996; Slater, 1999; see also Lickliter and Bahrick, 2000, for a recent review of this literature). A large portion of human cortex is devoted to integration of information between sensory modalities, particularly sound and vision. Tempo, or rhythm, is one such amodal feature and, using the habituation paradigm, one-month-old human infants show differential responding in the presence of synchrony or asynchrony between seeing and hearing the impact of an object on a hard surface (Bahrick, 1994; 2000).

We first review the infant literature on the transpositional relation of identity. The ability to attend to and respond on the basis of identity relations between stimuli has been suggested (in both the developmental and behavior-analytic literatures) as a critical stepping stone in the ability to form arbitrary classes of stimuli based on their relation to some contingency (Gentner & Ratterman, 1991; Premack, 1983; Sidman, 1994). Detection of identity relations of stimuli might focus an organism's attention away from the details or absolute properties of stimuli.

Young infants can attend and respond to similarity relations. Tyrrell and his colleagues (Tyrrell, Stauffer, & Snowman, 1991; Tyrrell, Zingaro, & Minard, 1993), utilizing a synchronous reinforcement paradigm (Coldren & Columbo, 1994), found that seven-month-old infants differentially responded to the intrapair relationships of identity and difference within a given problem set. Infants received training trials during which visual fixation to the target stimuli, either a pair of identical toys or a pair of different toys, was reinforced with access to an audio recording of a children's story. On test trials with *novel* pairs of toys, infants showed significantly increased looking at the pair that instantiated the previously reinforced relation (identity or difference), suggesting class formation based on identity. In addition, infants changed their responding to the opposite relation when the contingencies were reversed. Infants have also been shown to learn complex discriminations between familiar and novel stimuli using the habituation paradigm (Orlian & Rose, 1997; Rose et al., 1999), which suggests an understanding of same/different relations, and similarity relations have also been studied in older infants (Daehler, Lonardo, & Bukatko, 1979).

Studies involving matching-to-sample with discrete responses have produced some evidence of generalized identity with nonhuman primates using operant procedures (Bhatt & Wright, 1992; D'Amato & Colombo, 1985; Neiworth & Wright, 1994; Oden, Thompson, & Premack, 1988), a sea lion

(Schusterman & Kastak, 1993), older infants and children (Brown, Brown, & Poulson, 1995; 1997; Lipkens, Hayes, & Hayes, 1993), and even pigeons under special conditions (Wright, Cook, Rivera, Sands, & Delius, 1988; Zentall, Edwards, Moore, & Hogan, 1981; although see Iversen, 1997, for a criticism of these studies that suggests that identity matching performance in these cases may be best described as specific discriminations involving the spatial location of visual stimuli rather than identity; also see Thomas and Noble, 1988, for a discussion of the lack evidence for the concept of generalized oddity in nonprimate animals).

Other types of transpositional relational learning have also been examined in very young infants (Quinn, 1994). For example, in a study by Behl-Chadha and Eimas (1995), 3- to 4-month old infants showed dishabituation to a novel left-right spatial relation between a novel pair of animals. Familiarization training included multiple presentations of a horse and a zebra that varied in size, orientation, and location, but stayed the same with respect to the left-right dimension. Testing involved a novel pair of animals in reversed left-right relation and a novel pair of animals in the original left-right relation. The infants dishabituated to the novel left-right spatial relation. In other words, infants formed classes that included specific information about the left-right spatial dimension and indicated their formation of these classes by demonstrating a novelty response.

Turning to the learning of arbitrary relations, by six months of age, Hernandez-Reif and Bahrick (2001) showed that human infants are able to learn an arbitrary relation between the shape of an object and its color/pattern (the detection of a correlation, or repeated association, between two stimuli that share no absolute features). In this study, infants were repeatedly and simultaneously presented with two identical colored/patterned objects, one viewed above a barrier as the infant was allowed to touch and feel the other object below the barrier. During the test phase, infants were presented with the object below the barrier for tactile exploration and shown two poster boards above the barrier, one whose color pattern was identical to that of the object and one that did not match (control conditions included counterbalancing multiple objects and color patterns). Infants looked significantly more at the poster board that matched the color pattern of the object. Older infants demonstrate this ability to detect correlated features more quickly and with more complex object and events (e.g., Bhatt & Rovee-Collier, 1994; Bhatt, Wilk, & Rovee-Collier, 1996; Eimas & Quinn, 1994; Eimas, Quinn, & Cowan, 1994; Hernandez-Reif & Bahrick, 1996; Kaye & Bower,1994; Kuhl & Meltzoff, 1984; Lewkowicz & Turkewitz, 1980; Quinn, 1987; Quinn, Eimas, & Rosenkrantz, 1993; Walker-Andrews, 1986; Wilk, Bhatt, & Rovee-Collier, 1996; Younger, 1990; 1992; Younger & Cohen, 1983, 1986; Younger & Gotlieb, 1988).

The interest in infant ability to detect correlated features has been stimulated by the fact that correlated features are characteristic of basic-level categories (e.g., beaks usually "go with" feathers) (Malt & Smith, 1984; Medin, 1983; Rosch, 1978). Infants demonstrate their detection of the category exemplified by the correlated features when they show a preference for a novel stimulus with a pattern of correlations that violates the familiar correlation over a *novel* stimulus that maintains the pattern of correlated features (Quinn & Eimas, 1996).

> The abstraction of an invariant relation (i.e., the correlation) from a set of discriminable stimuli and the subsequent generalization to a novel stimulus is reminiscent of the definition of a category - an equivalence in response to a set of discriminable stimuli (Younger & Cohen, 1983, p. 865).

In addition, several researchers have demonstrated anticipatory and reactive responses (in the form of eye saccades) to (a) repeated pairings of a brief stimulus at a cued location or an arbitrary abstract visual pattern and the subsequent presentation of another stimulus at the cued location, and (b) presentation of a sequence of alternating pictures that reliably predicts information about spatio-temporal patterns (Canfield & Haith, 1991; Gilmore & Johnson, 1995; Haith, Hazen, & Goodman, 1988; Wentworth & Hood, 1996).

Finally, evidence exists for a developmental progression in these particular relational learning abilities, such that the learning of transpositional and arbitrary relations are facilitated by the presence of amodal information (see Hernandez-Reif & Bahrick, 2001 and Bahrick & Pickens, 1994, for discussions). The perceptual features of an amodal relationship (e.g., tempo) between two stimuli are more abstract, although not necessarily perceived any less directly nor requiring any postnatal experience or learning in a species with the requisite sensory and cognitive apparatus than unimodal identity matching. Recall that one-month-olds can discriminate between synchronous and asynchronous temporal information across vision and hearing (Bahrick, 1994; 2000). Critically, by seven months of age, infants learned arbitrary auditory-visual feature combinations (a vowel sound "goes with" an object) when the object was moved in synchrony with the speech sound, but not in the absence of such amodal information (Gogate & Bahrick, 1998). Repeated experiences across the early infancy period with arbitrary relations that also contain amodal relations may contribute to the capacity for integrating a generalized identity concept (and other transpositional relations) with the functional information available in equivalence classes. The importance of the ubiquity of redundant visual, auditory, tactile and temporal information present in human infant-caregiver vocal, facial, and gesture communications, and the role of imitation, for language acquisition is also being investigated using this paradigm, as a model for the types of experiences in human infancy that might facilitate fluency and flexibility in these capacities (Gogate, Bahrick, & Watson, 2000; Gogate, Walker-Andrews, & Bahrick, 2001; Lickliter & Bahrick, 2001).

These infant relational learning capacities are all being found to occur in an age range *prior* to the onset of the production of words (although critically, potentially concurrently with the onset of first word comprehension). Furthermore, the merger of absolute-feature based classes, classes based on transpositional relations, and arbitrary "goes with" class formation, in any and all combinations, provides models of the emergence and use of complex categories and concepts that form the basis of much of human cognitive behaviors related to language (Fields, Adams, Brown, & Verhave, 1993; Fields, Reeve, Adams, Brown, & Verhave, 1997; Lane, Clow, Innis, & Critchfield, 1998).

In addition to the theoretical significance of an integration of current knowledge derived from this ongoing research in behavior analysis and infant cognitive developmental science, the application of behavior-analytic methods may help address specific concerns regarding current infant research. First, Bahrick and Pickens (1995) have noted problems in the infant categorization work having to do with changes in preferential looking to novel versus familiar stimuli as a function of time between training and testing. This would suggest the need to use long term, intensive (i.e., longitudinal, small-N) research designs similar to those used in operant psychology (thus far, all of the infant research is cross-sectional). In addition, variability in performance across subjects is a difficulty for infant group design studies. Operant methods typically minimize these problems through the careful monitoring of baseline performance, and the use of subjects' own performance as the control (Reeve, Reeve, & Poulson, 1993).

## Conclusion

The next obvious extension of this research is to use operant techniques, rather than the habituation/visual preference paradigm. The most basic type of contingency-based learning of arbitrary relations can be seen in the behavior-analytic research on the formation of functional stimulus classes. A functional class is a class of stimuli that are related because a certain response is reinforced in the presence of those stimuli. For example, in the classic study with pigeons, Vaughn (1988, 1989) arbitrarily selected two groups of stimuli from 40 different slides of trees and established differential responding to these two sets with differential reinforcement training. In other words, during training, responding to one of these classes was followed by food and responding to the other was not. Subjects learned to respond to the stimuli followed by food. Then the contingencies were reversed (the class that had previously been reinforced was no longer reinforced and vice versa) and the subjects learned the new set of contingencies. After multiple reversals, the subjects learned to reverse their responding to all members of each class after experience with just a few trials. Similar results have been obtained in adult humans (Sidman, Wynne, Maguire, & Barnes, 1989). Although classes formed on the basis of similar function have been investigated in young infants (Greco et al., 1990), and performance has been reversed by reversing contingencies in the examination of identity/difference relations as discussed above (Tyrrell et al., 1991, 1993), the reversal discrimination paradigm using classes formed through functional equivalence procedures has not been explored in human infants. If successful, the full operant paradigm for the building of equivalence classes could then be attempted.

## Summary

In summary, categorization of environmental stimuli is a fundamental aspect of all cognitive/behavioral systems (Estes, 1994; Quinn & Eimas, 1996). It entails the ability to discriminate stimulus features embedded in a multiple-feature stimulus array and the ability to operate on discriminably different stimuli in a similar way. Furthermore, non-perceptual relational learning categorization abilities are recognized as a critical set of skills associated with vocabulary and language acquisition (Gentner, 1977; Gershkoff-Stowe, Thal, Smith, & Namy, 1997; Poulin-Dubois, Graham, & Sippola, 1995; Roberts & Horowitz, 1986; Sidman, 1994; Woodward & Hoyne, 1999). Integration of infant cognitive development research with behavioral analyses in this area is a critical next step in our understanding of these processes.

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# Naming, Story-Telling, and Problem-Solving

## *Critical Elements in the Development of Language and Cognition*

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*In the current article, we present the three pillars of Relational Frame Theory: relational frames, relational networks, and abstraction from and transformation of the nonarbitrary environment, with the examples of naming, story telling, and problem-solving, respectively. The main thesis of the current paper is that these processes are necessary for a complete behavioral account of the development of language and cognition because so much of human behavior is verbal, at least in part. The paper describes the overlap between the three pillars to illustrate the synergistic interaction in their development and the extent to which Relational Frame Theory is a developmental account of verbal behavior as a dynamical system. With a relatively limited array of interactive psychological processes, it is argued that Relational Frame Theory allows complex verbal events, such as story-telling and problem-solving, to be approached behaviorally and developmentally.*

The study of language and cognition has played a key role in the mainstream literature in developmental psychology, whereas the behavior-analytic approach to development has been far less concerned with these two domains. Unlike traditional developmental researchers, behavioral psychologists in this field are likely to be less concerned with tracking common, qualitative, and cumulative changes across time (Chomsky, 1959; Piaget, 1967) than with identifying the basic behavioral processes that might give rise to these complex repertoires (e.g., Fischer, 1980). In the study of these basic processes, behavioral researchers have relied heavily upon the direct-contingency account of human verbal behavior presented by Skinner (1957). And, as is well known, this approach has often been criticized for not capturing the symbolic and emergent qualities that define human language and cognition (e.g., Chomsky, 1959; Hayes & Hayes, 1992).

Within behavior analysis, some researchers have pointed to the growing literature on derived stimulus relations as the basis of a new account of language and cognition, known as Relational Frame Theory (RFT: Hayes, Barnes-Holmes, & Roche, 2001a). The main advantages of this approach are that it retains its roots in the philosophical contextualism of behavior analysis and continues to draw on well-established behavioral principles, but also supplements the direct-contingency analyses that form the core of Skinner's *Verbal Behavior.* Relational Frame Theory, like any behavioral account, is inherently developmental in orientation and focuses on streams of organism-environment interactions. Because these interactions are considered in terms of both historical and current contexts, development or change is assumed and expected for the individual. According to RFT, this development involves three core theoretical concepts: relational frames, relational networks, and abstraction from and transformation of the nonarbitrary environment. Each of these pillars is implicit in the others and all are developing simultaneously, but what is barely seen at one level becomes dominant at another" (Hayes, Barnes-Holmes, & Roche, 2001b p. 112). Archetypal examples of these three pillars are naming, story telling, and problem-solving, respectively. In the present article, we describe these three examples and argue that the three pillars of RFT may be essential features of a coherent behavior-analytic account of the development of human language and cognition.

## Relational Frames and Naming

Relating quite simply means to respond to one event in terms of another, and most living organisms appear to be capable of responding to relations among the physical or *nonarbitrary* properties of stimuli (e.g., responding to the larger or the duller of two stimuli, Reese, 1968). In addition, relational responding itself can be abstracted and brought under the contextual control of features other than the formal properties of the stimuli. The term *arbitrarily applicable* is used to describe this type of relational responding because in some contexts it is under the control of cues that can be modified entirely by social convention. For example, when playing a game with a child, you might say, "This time, more means less, and less means more," in which case, the relational functions are *applied* in an entirely *arbitrary* fashion. The term *relational frame* then refers to specific patterns of arbitrarily applicable relational responding.

In order for arbitrarily applicable relational responding to develop, the child must learn to discriminate between the relevant features of a task (i.e., responding to one event in terms of another based on the presence of a contextual cue) and the irrelevant features (e.g., the physical properties of the stimuli involved). The earliest social interactions of children are dominated by this type of learning, of which naming (i.e., responding to the symmetrical relations between words and their referents) is a prime example.

A young child's early language history consists of a wealth of name-object and object-name interactions across a multitude of objects and names (e.g., edibles, toys, people, animals etc.). Across these interactions, symmetrical relations between the names of objects and actual objects are directly reinforced. For example, a mother may say, "Where's Teddy?" And then pick the teddy up and tickle the child with it (name-object relations). Similarly, she may ask, "What's this?" while holding up the teddy and may then say to the child, "It's Teddy" (object-name relations) and tickle the child again. Across time, symmetrical responding comes under the control of specific contextual cues such as "What's this called?" and the juxtaposition of objects and words. According to RFT, this type of history provides a basis for *generalized* symmetrical responding. Training in new name-object relations, therefore, will generate new or *derived* object-name relations (or vice versa) in appropriate contexts. If generalized symmetrical naming is possible, similar patterns with other kinds of relations should also develop. Relational Frame Theory uses a specific nomenclature to describe these performances.

*Mutual entailment* describes the bidirectional mutually entailed nature of arbitrary stimulus relations. For example, if A is related to B, B must be related to A. Although these relations are bidirectional, they are not always symmetrical. For example, if A is *larger* than B, then B is *smaller* than A (not the same as A). Arbitrarily applicable relational responding is brought to bear on a situation by contextual cues, such that if in a given context A is related in a characteristic way to B, then in that context, B will be related in another characteristic way to A.

*Combinatorial entailment* refers to a derived relation in which two or more stimulus relations (trained or derived) mutually combine. For example, if in a given context, A is related to B and A is related to C, then B and C will be combinatorially entailed in that context. For example, if good is the opposite of bad, and "maith" is the opposite of bad (as in the Irish language), then a derived combinatorial relation between good and "maith" is entailed. Combinatorially entailed relations must be specified explicitly, although the derived relations may be much less precise than the original relations. For example, if A is different than B and B is different than C, we cannot specify the precise relation between A and C or C and A (i.e., they may be the same or different). According to RFT, combinatorial entailment, with its specificity and complexity, probably emerges later in language development than mutual entailment (Lipkens, Hayes, & Hayes, 1993).

*Transformation of stimulus function* is the term used when the functions of a stimulus are altered in accordance with derived relations. Transformation of function is a defining characteristic of relational responding because it allows derived relations to have psychological content. For example, if a person is trained to select stimulus A as "more than" B, and if A is given a conditioned reinforcing function, then B should have a derived smaller reinforcing function because of its "less than" relation to A (Dougher, Auguston, Markham, Greenway, & Wulfert, 1994; Dymond & Barnes, 1995; Hayes, Brownstein, Devany, Kohlenberg, & Shelby, 1987). In order for derived relations to have appropriate psychological content, the transformation of stimulus functions must come under contextual control. For illustrative purposes, consider the bidirectional relations between the word "lemon" and an actual lemon (i.e., they participate in a frame of coordination). A number of stimulus functions are present in lemons, including the perceptual functions of taste (bitter), texture (rough), and sight (yellow). When instructed to "think of a lemon," most of us could easily come into contact with the functions of a lemon (we may even begin to salivate in response to the derived taste functions) even when no such object is present. In this example, the words "think of" act as a context in which the perceptual functions of lemons are elicited in accordance with the underlying relation. This example demonstrates the importance of contextual cues not only in establishing and indicating the particular conditions under which relational activity occurs, but also in specifying precisely which functions should be transformed.

In the early stages of language training, it is likely that inappropriate stimulus functions participating in derived relations will be transformed before the reinforcement contingencies establish appropriate contextual control. If, for example, a young child is told that an actor is a star, this may cause confusion, because the actor does not look like an actual star. Through differential reinforcement from the verbal community, however, the child will learn that in the context of saying someone is a star, the perceptual functions should not transfer to the person unless additional cues are offered (e.g., the words "his face looks like a star").

Let us summarize what we have said so far. A relational frame is a specific kind of arbitrarily applicable relational responding that has three sets of properties: (a) it shows the contextually controlled properties of mutual entailment, combinatorial entailment, and the transformation of functions; (b) it results from a history of relational responding relevant to the contextual cues involved; and (c) it is not based solely on direct training with regard to particular stimuli, nor solely on the nonarbitrary characteristics of either the stimuli or the relations among them. Developmentally, naming seems to provide an important basis for the development of relational frames in the behavioral repertoires of young children. For example, mutual entailment may occur between a name and an object (e.g., "car" and an actual car), combinatorial entailment may occur among two or more names and the same object ("car," "automobile" and an actual car), and the psychological functions of names may be transformed in the context of other words (e.g., "imagine the sound of a car").

From the perspective of RFT, therefore, naming provides the "entering wedge" into the world of human language and cognition. The derived relations made possible by a repertoire of naming allow for the establishment of much more complex derived stimulus relations, referred to in the language of RFT as relational networks. Naming, of course, continues to develop (e.g., with a growth in vocabulary) as relational networks also emerge. These two repertoires, therefore, do not constitute sequential stages of development, although it seems highly implausible that relational networks could emerge without some prior repertoire of derived naming.

## Relational Networks and Story Telling

The concept of a relational network provides a means of conceptualizing and studying the organization of larger language units commonly known as sentences, paragraphs, stories, and so on. Consider the simple sentence, "This is a cup," as an example of a relational network. The word "cup" participates in a frame of coordination with an actual cup. The phrase "This is a" may participate in a frame of coordination with other contextual cues that control the frame of coordination itself (e.g., "goes with"). The word order of the sentence establishes grammatical relational frames, enabling the listener to respond appropriately to the sentence. For example, "This is a cup" is not the same as "Is this a cup?" and each requires a different response from the listener. In certain contexts, however, the word "cup" may function in exactly the same way in "This is a cup" and "Is this a cup?" but this is determined by a range of contextual cues, such as the conversational context and the facial expression of the speaker. According to RFT, therefore, virtually any discrete event (e.g., words, grunts, or even a raised eyebrow) may function as part of a relational network if the historical and current context supports the relevant relational functions.

Relational networks can be more or less complete, depending on the extent to which the events in the network, and the network itself, serve as a context for relational activity. The simplest level of a complete relational network appears to correspond to what is commonly described as a sentence. At the level of a sentence, a network is said to be complete if terms (serving as contextual cues) set the occasion for adequate relational activity to specify a relation or relations between or among all of the events in the network (i.e., making the network complete).

Even larger language units (e.g., stories) can be approached from this perspective. Specifically, a relational network can be complete in a local sense (e.g., at the level of a sentence), but not in a larger sense because previous verbal material or the general verbal context indicate that a larger relational network is being formed in this instance but is not yet complete. For illustrative purposes, consider the following example. Imagine a parent says to a young child: "Let me tell you a story. Once upon a time there was a princess who lived in a castle with her wicked stepmother." If the parent then stopped abruptly, even a very young child would insist on hearing more. In this case, the child's history with larger relational networks or "stories" combine with cues (e.g., the phrase "Let me tell you a story") to establish a relational function. Although the statement "Once upon a time there was a princess who lived in a castle with her wicked stepmother" is a complete sentence because a relational context is fulfilled at this level, it is not a complete story because the larger relational network should specify what happened between the princess and her step-mother.

Even a very young child will attend for a long time to a good story because the development of the relational network establishes coherent and direct stimulus functions. In other words, the reinforcing value of stories is based *merely* on the properties of developing complex relational networks and transforming psychological functions in terms of these relations. For example, the child can "imagine" the events in the story in a similarly reinforcing manner as if these had actually occurred (e.g., feeling happy when the dwarves defeat the stepmother to save the princess).

The RFT account of story-telling, therefore, involves relating networks of stimulus relations. This process is central to the relational frame account of the development of language and cognition, because it appears to explain the generativity, richness, and complexity of these abilities, as commonly described. For instance, relating networks of stimulus relations is enormously efficient and generative. Hundreds or thousands of already-established stimulus relations in one domain can be brought to bear on another domain, thereby generating a wealth of derived relations.

## Abstraction from and Transformation of the Nonarbitrary Environment and Problem-Solving

In a given instance, nonarbitrary stimulus relations may be indistinguishable from arbitrary relations applied to the nonarbitrary world. Consider, for example, two clear glass jars full of sweets. The jars both hold the same amount of sweets, but one is tall and thin while the other is short and broad (as typically presented during traditional tests of the Piagetian concept of conservation). A young child who is asked "Which has more?" will likely point to the taller jar. The child's pointing in this instance *looks like* a nonverbal event because of the prominent non-arbitrary differences between the two stimuli (i.e., the chosen jar is actually taller). Indeed, a well-trained nonhuman with an appropriate history of responding to differently sized objects and the nonarbitrary stimulus relations between them could probably accomplish this task (as a nonverbal response). Relating the two jars for the child, in this instance, may in fact be described as an arbitrarily applicable relational response that is not arbitrarily applied on this occasion. The relevant history that is brought to bear on this occasion involves both arbitrary training and nonarbitrary features of the environment. This example illustrates one way in which the nonarbitrary environment can become involved in arbitrarily applicable relational responding. Specifically, the nonarbitrary relations set the occasion for verbal or arbitrary relations but the former relations themselves do *not* enter into relational frames. For example, imagine a young boy presented with two spherical objects placed on a table in front of him. One of the objects is a large inflated balloon, while the other is a small baseball. When presented with these objects, the young child may be able to respond correctly to the instruction "Which one is larger?" without the word "larger" participating in relational frames with the relevant formal dimension or other words. If this were the case, the child would not be able to respond to the question "What's another word for larger." The functions of the physical environment (i.e., "larger than") responsible for the relational responses are not transformed, and as such are not verbal.

Nevertheless, deriving the correct response in either of the examples above (i.e., the jars of sweets and the balloon/baseball examples) may still be verbal because it involves the application of a relational frame. Specifically, RFT employs the term *pragmatic verbal analysis* to refer to the verbal analysis of the nonarbitrary world when that analysis involves acting upon the world verbally, and having the world serve verbal functions as a result. Consider the child in the balloon/baseball example. In other contexts, "air" and "heavy" may participate in a relational frame of "difference" for the child (i.e., "air is not heavy"). If the child is subsequently asked: "Which one has more air in it?" and "Which one is heavier?" He may point to the balloon in response to the former question and to the baseball in response to the latter question. In this case, we might conclude that the child's original performance was regulated verbally by nonarbitrary features of the environment, and as such involved pragmatic verbal analysis. Similarly, a child who chooses the taller jar in the original example may be responding verbally if that response participates in a class with behaviors that are controlled in other contexts by arbitrary contextual cues (i.e., when a stimulus is arbitrarily designated as "larger" or "smaller than" another stimulus). According to RFT, therefore, much of what is considered nonarbitrary in human behavior is verbal in the sense that it involves pragmatic verbal analysis, because any nonarbitrary dimension that one can speak about meaningfully can function verbally.

Problem-solving is a common example of pragmatic verbal analysis. During this type of verbal behavior, complex "purposive" interactions with the natural environment that produce specific verbally-constructed consequences can be performed. In more traditional behavioral terms, problem-solving is said to alter the behavioral functions of the environment under the antecedent and consequential control of an apparent absence of effective action. In the language of RFT, this absence functions as an antecedent for relational activity that is itself oriented toward the establishment of such actions. Developmentally, this is a relatively sophisticated repertoire of cognitive skills, and thus it is not surprising that children do not demonstrate efficient problem-solving at a young age. For example, five-year-old children typically fail many of the problem-solving tasks that are taken to be measures of *executive function* in traditional cognitive psychology (Hughes, 1998; Perner & Lang, 2000).

According to RFT, all forms of problem-solving involve the discrimination of a problem state (i.e., the absence of effective action) and, to some degree, a discrimination of the problem solution. What differs across problems, however, may be the degree to which the solution to the problem is discriminated verbally. A *strategic problem* involves solutions that have been identified verbally to a large or complete extent. More informally, a good problem-solver has typically learned across exemplars to place the desired goal into a relational frame where it can be compared to existing verbal networks that specify the current situation and steps necessary to reach the verbally constructed outcome.

Traditional views of problem-solving correlate with this type of problem-solving because of the linear or step-like application of verbal relations. For instance, the following sequence is frequently described: Define Problem; Gather Information; Identify Possible Solutions; Select Plan; Carry out Plan; Test Outcome; Change Plan (see Reese, 1994). These common sense steps comprise domains in which verbal activity may occur, with each referring to the desired verbally constructed outcome. The step-like quality of strategic problem-solving does not result from the necessarily linear nature of verbal events themselves, but from the attempt to formulate heuristic strategies verbally. In other words, the step-like analysis of problem-solving is more prescriptive than descriptive.

Unlike strategic problem-solving, *evaluative* problem-solving applies when the lack of effective action is verbally accessible, but not adequate to constitute effective action. This type of problem-solving involves the use of relational frames to contact possible outcomes, so as to select among them. It is the verbal analog to reinforcer sampling, or forcing an animal to both sides of a concurrent chain, but in this case the "contact" is through the transformation of stimulus functions through a network of derived stimulus relations. For example, a child may choose between going to the mall and going to the movies by verbally listing each of the positive features of both activities to determine which might be preferred in this context. A broadly similar strategy may be adopted in adult life in the context of major life decisions, such as employment and careers, marriage, or religious practices. Once again, the problem may be more about the selection among possible consequences as it is the means of reaching consequences that are selected, and thus faced with problems of this kind, an adult may construct a list of pros and cons to try to abstract features of the situation that might be contacted.

## Summary

We presented the three pillars of RFT: relational frames, relational networks, and abstraction from and transformation of the nonarbitrary environment. Archetypal examples of these pillars in terms of naming, story telling, and problem-solving, respectively were also presented. From the perspective of RFT, these processes are necessary for a complete behavioral account of the development of language and cognition because human behavior is so often verbal, at least in part. The RFT approach to development in these domains is more dynamical than stage-like because each pillar is implicit in the others and all are developing simultaneously. A history in one is likely to facilitate the on-going development of another. For example, many going development of another. For example, many names are required to give stories breadth, and contextual control of different types of relational frames is required to give stories meaning, and to allow them to be compared. Precise naming skills are also required in order to problem-solve. Story-telling may also enhance problem-solving. For example, if the outcome of a story results from baiting a giant with food, a child may employ a similar strategy to get the dog out of the garden. Similarly, story-telling in turn will facilitate the expansion of existing relational networks.

These examples of the overlap between the three pillars of RFT illustrate the synergistic interaction in their development and the extent to which RFT is a developmental account. In this sense, therefore, RFT approaches the development of verbal behavior as a dynamical system. Based on a relatively small array of interactive psychological processes, RFT thereby allows even complex verbal events, such as story-telling and problem-solving, to be approached behaviorally. From this perspective most human actions are verbal, and any account of thė development of language and cognition should pay close attention to this fact.

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# Some Reflections on Postformal Stage

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*After having reviewed the most important conceptualizations on post-formal knowledge and described the characteristics of this level, the author criticizes some of them, analyzes whether it is possible to speak of a fifth stage of development beyond formal operations, and makes some considerations about the models of development underlying studies of adult behavior.*

For decades, the terms *human development* and *psychological development* were seen as related to childhood and adolescence, that is, to the first twenty years of life. Traditionally, experts in developmental psychology analyzed the growth of the child and of the adolescent, holding that development ends before adult life begins. One of the authors who defended this position was Piaget. According to Inhelder and Piaget (1955) formal operations are due to (a) the unlimited expansion of its scope; (b) its increasing mobility and, simultaneously, stability; (c) its total deductiveness; (d) its total operational reversibility, and (e) its total logical necessity; this manifests a complete and final equilibrium and represents the end of the operational development of intelligence, "which in no way rules out the new integrations and continuous surpassing proper to adult thought" (p. 3). Fifteen years later Piaget maintains, "[formal operations] constitutes the essence of the logic of educated adults, as well as the basis of the elementary forms of scientific thought" (Piaget, 1970/72, p. 6). These statements, widely criticized, compelled a group of authors to raise the hypothesis that there could be a stage (or stages) beyond formal operations that would better represent adult behavior. According these authors (cf. Arlin, 1975; Basseches, 1980, 1984; Commons, Richards & Armon, 1984, Commons, Sinnott, Richards & Armon, 1989; Kramer, 1983, 1990; Labouvie-Vief, 1980, 1984, 1990, 1992; Pascual-Leone, 1984; Riegel, 1973; Sinnott, 1981, 1984, 1989, 1993, among others), cognition, owing to the broadening of social experience and the continuous need for new competencies (cf. Labouvie-Vief, 1980, 1992; Kramer, 1983, 1990), continues to develop during adult life, assuming forms that are more complex and less directly dependent than adolescent cognition upon the logic of truth *versus* falsity. In Labouvie-Vief 's words (1992), in Piaget's theory:

> ...mature thinking is described primarily in terms of the noncontradictory thinking of formal operations . . . Piaget's adolescent is described almost exclusively in terms of idealized structures of mathematical and scientific thinking. But this offers only a partial account of mature thought, which needs to embrace contradiction and tension as well (p.202).

With the aim of expanding the Piagetian view of formal operations, various theories arose (cf. Arlin, 1975; Basseches, 1980; Commons, Richards & Armon, 1984; Commons, Sinnott, Richards & Armon, 1989; Kramer, 1983; Pascual-Leone, 1984; Riegel, 1973; Sinnott, 1981, 1984, 1989, among others) which were based on the assumption that the distinctive characteristic of adult behavior was the acceptance and integration of various, and at times incompatible, truths that are highly dependent upon context and upon the way in which the subject perceives them, without the subject needing, as the adolescent does, to look for and to find a single truth. Such theories provoked great enthusiasm in the scientific community. According to Sinnott (1993), we were in the presence of a "new area" of development, called "post-formal".

## The Underlying Theoretical Conceptions of Development

Although critical of the Piagetian theory of formal operations in particular and of some aspects of his theory of development in general, most researchers at first attempted to apply core assumptions of the Piagetian model of development to the study of adulthood (Labouvie-Vief, 1992). Most formulations of post-formal thought have taken the form of one general stage; development is seen as progressing from absolute, dichotomous modes of thinking, which characterize formal operations, to levels in which individuals expand their knowledge. For instance, Arlin (1975) speaks about a fifth stage, named "problem finding" as opposed to the fourth stage (Piaget's formal stage) which she calls "problem solving." Commons et al. (1982) portray their stages as third- and fourth-order operations in continuity with the second-order operations of the formal operations stage. Although the Piagetian model of development underlies most conceptualizations of post-formal behavior (the term itself is inspired by the Piagetian designation of formal operations), it has been the target of various criticisms. For most adult development scholars, the Piagetian conceptualization fails because of: (a) its claim that the stage of formal operations constitutes the last stage of psychogenesis; (b) the excessive value it gives to the structural dimension, to the detriment of the dialectical dimensions; (c) the model of formal operations, which appeals excessively to the logic of the truth tables; (d) the separation of thought from the processes of the self, of context, and of history; (e) the lack of parsimony and of empirical adequacy of the Piagetian tasks employed in the evaluation of adult subjects; and (f) in not showing that stages *exist* as anything more than *ad hoc* descriptions of sequential changes in human behavior. To overcome such limitations, specific tasks were proposed to evaluate adult development; descriptions of adult behavior were made in which diverse dimensions (cognitive, subjective, intuitive, imaginative, interpersonal) were integrated; and other models were used, namely the dialectical model (cf. Basseches, 1984; Kramer, 1983; Riegel, 1973) and the relativistic model (cf. Sinnott, 1984, 1991). The dialectic model, divulged by Riegel (1973, 1975, 1976), claims that development consists of continuous and constant changes in which contradictions would be the motor of advances, there being--contrary to what Piaget postulated--no stable levels of equilibrium. The subject does not necessarily effect, as was postulated by Piaget, an equilibration of conflicts. On the contrary, dialectical thought that characterizes maturity consists of living with contradictions.

The relativistic model, based on axioms and properties of the relativistic model of Einstein, exerted (just as the dialectical model did) a great influence on the majority of the conceptualizations of post-formal behavior. According to Sinnott (1981, 1984, 1989, 1993), the pre-relativistic model of Newton and the relativistic model of Einstein reveal different assumptions regarding knowledge: absolutistic assumptions, in the case of Newton's model and relativistic, in the case of the more recent models. In her view, the Piagetian analysis of formal operations was inspired by the Newtonian. For Sinnott (1984), the "soft," relativist model, by containing the "strong" Newtonian logic in a broader system of relationships among elements, would be a more adequate model for representing post-formal behavior than the bivalent-logic model of propositions.

Most descriptions of post-formal thought are based on a dialectical epistemology and on an epistemology of relativity (e.g., notions such as dialectical operations, logical relativism, contextualism, self-reference, and acceptance of contradiction).

In a line of study that differs from that of most post-formal researchers in its view of post-formal level as more logical and operative than experiential, Commons et al. (1998), considering the various criticisms of traditional stage theory for not showing that stages exist as anything more than *ad hoc* descriptions of sequential changes in human behavior, have come up with alternatives to the Piagetian model of stages (the Model of Hierarchical Complexity and, more recently, the Behavioral Model of Development Stage) in which, as will be pointed out further on, stages are no longer means of classifying instances of thinking shown while working on some tasks but become "the highest order of hierarchical complexity on which there is successful task performance" (p.237-238).

## References to a Stage beyond Formal Operations

The first references to the eventual existence of a stage beyond the formal were made by Bruner (1959) in his critique of Inhelder and Piaget's description of formal operations (1955). In Bruner's opinion--and, later, in the opinion of Gruber and Vonèche (1976) and of Commons and Richards (1984a,b)--such a stage would not be universal, as only a few scientists (e.g. Piaget) would manifest such a level of development. Years later Riegel (1973), one of the first authors to postulate the existence of a fifth stage of development, characterized adult creativity by dialectical operations. Arlin (1975;1984), for one, proposed a fifth stage of development characterized by the progressive substitution of *problem solving* (the dominant activity, in his opinion, of adolescent behavior) by *problem finding* (an activity which is, according to this author, constant in, and distinctive to, adult behavior). Labouvie-Vief (1984, 1992) described adult development by logical relativism and by progressive reference to the Self. Kitchener et al. (cf. Kitchener & Brenner, 1990; Kitchener & King, 1981, 1990a,b) claimed, in their reflective judgment model, that there existed higher stages, in which knowledge is conceived of as relative, circumscribed, and resulting from a constant evolution that is susceptible to being evaluated and re-evaluated. For Kramer (1983) post-formal thought, which is of a relativistic and dialectical nature, is independent from bipolar logic (i.e., from the true/false dichotomy), allowing the subjects to become conscious of the existence of mutually incompatible systems arising from the subjective and arbitrary nature of knowledge (Kramer, 1983, 1990). Commons and his colleagues (cf. Commons, Richards & Armon, 1984; Commons, Richards & Khun, 1982; Richards & Commons, 1984, 1990) describe stages of development qualitatively distinct from and logically more complex than that of formal operations (the systematic, the metasystematic, the paradigmatic and the cross-paradigmatic stage), in which subjects become progressively capable of analyzing and of coordinating diverse systems, creating supersystems of a metatheoretical nature.

The great diversity of theories, and of methodologies presented by authors who postulate the existence of stages of development beyond the formal operations stage, makes it difficult, if not impossible, to get a unified view of the characteristics of this level of thought. However, it is possible to identify in the diverse descriptions of post-formal knowledge (cf. Kramer, 1983, 1989) some features which would be specific to this level: (a) the recognition and understanding of the *relativistic*, non-absolutist, *nature* of knowledge; (b) the *acceptance of contradiction* to the extent that it is part of reality; and (c) the *integration of contradiction into comprehensive systems*, i.e., into a dialectical whole (Kramer, 1989).

Relativistic knowledge, which develops in young adulthood, is characterized by two features: (a) the *acceptance of incompatible systems of knowledge* (Kramer, 1983; Labouvie-Vief, 1980; Riegel, 1973; Sinnott, 1984, 1993) and (b) the *recognition of the subjective and arbitrary nature of knowledge* (Kramer, 1983, 1990; Riegel, 1973; Sinnott, 1984, 1993). In a relativistic view of the world, contradictory and incompatible phenomena or systems can co-exist, since their meaning depends upon context and upon separate points of view, unrelated to each other (Kramer, 1989). Thus, relativistic thought can, if contradiction is not integrated into comprehensive systems, lead ultimately to immobility, and even to chaos (cf. Kitchener & King, 1981; Kramer, 1990).

Acceptance and integration of contradiction, which develop mostly in middle age, though there are great individual differences, are the most distinctive and salient features of adult knowledge (cf. Arlin, 1984; Basseches, 1984; Kramer, 1983; Labouvie-Vief, 1980; Sinnott, 1984; Riegel, 1973). Although the post-formal theorists might not differentiate between conceptualizations and contradiction, Kramer (1989) distinguishes contradiction which is postulated according to a relativistic conceptualization (based upon contextualistic assumptions) from contradiction postulated according to a dialectical conceptualization (deriving from organismic assumptions). In organismic assumptions, contrary to contextualistic ones, change occurs in a systematic (and non random) manner, results from the resolution of conflicts (and not from their coexistence), and leads to greater unity and coherence (and not to extreme multiplicity). Thus, to avoid falling into immobility, to which extreme relativism can lead, it becomes necessary to integrate contradiction into more inclusive systems constituted by two or more formal systems. Integration of contradiction is found in the highest levels by Kitchener and King (1981), in the autonomous level by Labouvie-Vief (l980; l984; 1990), and in the metaformal schemata of Basseches (1984; 1989), to mention a few authors.

## Reflections on Characteristics of Post-formal Reasoning

As mentioned above, various authors, based on Einstein's theory of relativity, contrast absolutistic reasoning with relativistic reasoning, the latter generally seen as being characterized by the acceptance of incompatible systems of knowledge, and by the recognition of the subjective and arbitrary nature of knowledge and of its dependence upon context. This characterization of relativistic thought raises various questions, the first of which is whether it reflects what Einstein meant by relativism. The theory of relativity (cf. Holton, 1998) doesn't reach the conclusion that truth depends upon the observer's point of view. According to this theory, the most important truths of science are independent of varying points of view. The laws of physics are formulated such that they are valid for all observers, independently of the way in which the observer is moving or of where he is located. This being the case, it doesn't seem legitimate to invoke Einstein to claim that knowledge depends upon diverse systems of reference, upon different points of view, or upon different contexts. Relativity in physics, on the contrary, teaches us that we can extract from different systems of reference all the laws of physics, these being invariant. In Holton's words (op. cit., p. 154), "it is for this reason that, in contrast with classical physics, modern relativity is simple, universal, and, we can even say, 'absolute'. The cliché in fashion is, erroneously, "everything is relative," when the important point is that, out of the vast flux of all events; we can extract exactly the opposite: some things are consistent. [1]

Holton's interpretation of Einstein's theory of relativity reminds us more of Piaget than of certain post-formal theorists.[2] It is true that some post-formal theorists identify different levels of relativism, the first levels being of a more radical character, but in the higher levels, besides the assumption of idiosyncratic and contextual variables, more valid epistemological justifications are sought. However, considering that these higher levels, in which contradiction is integrated into more inclusive frameworks, are not universal (i.e., few adults display them), it can be said that adult could manifest an immobilizing and, eventually, chaotic relativism, which has little or nothing to do with Einsteinian relativism. Another question concerns the findings of studies which don't support the hypothesis that relativity represents a postformal development (see Kramer & Woodruff, 1986).

As to *acceptance of contradiction*, and its *integration into inclusive systems*, it is important to see whether these two behaviors aren't ever manifested in the highest level (level B) of formal operations. Let us take, for example, the INRC group (cf. Inhelder & Piaget, 1955), the structure that is subjacent to formal operations. Upon resolving problems that presuppose the co-ordination of an initial operation with its inverse, its reciprocal, and its correlative, subjects not only are confronted with contradictory situations, but will also integrate this contradiction. If it must be admitted that at the beginning of formal operations such co-ordination is seen to be difficult, it is legitimate to suppose that at the consolidated level (level B) of formal operations, this co-ordination is accomplished, generalized, and applied in an increasingly greater number of possible instances. The following statement of Piaget and Inhelder and (1966/1971) clarifies this:

> ...the beauty of the new (INRC) system, which is now established and which demonstrates the character of synthesis or of consolidation (waiting, naturally, to be integrated into more encompassing systems), is that there is not simply juxtaposition of inversions and of reciprocities, but operatory fusion into a unified whole, in the sense in which each operation will be from now on simultaneously the inverse of another and the reciprocal of a third, this last being at the same time the correlative (. . .) of the first" (Piaget & Inhelder, 1966/1971, p. 110).

This being the case, these two characteristics considered to be distinctive of post-formal operations can already be manifest at the level of formal operations. The failure of certain post-formal theorists to consider the levels of development (from genesis to consolidation) within formal operations constitutes a significant

[1] It is notable that Einstein seemed to like the term "*Invariantentheorie*" better than "theory of relativity", the title first given to Einstein's theory by Plank and Abraham in 1906.

[2] As a matter of fact, Piaget knew Einstein personally and sometimes referred to him in his books, for example, in *A Child's Conception of Time*, in which, according to Piaget, he attempted to answer a series of questions raised by Einstein.

lacuna which can lead to the undervaluing of the potentialities these operations.

## Can We Speak of a Fifth Stage of Development beyond Formal Operations?

Everything leads us to believe that there can be development during adult life. Then it is important to know whether the fifth stage of development, which the bulk of theorists propose as being beyond the formal, actually reveals a structural change of a level above that of formal operations. Alternatively it is not more than a group of competencies of a practical and contextual nature, relating to specific realms (cf. Labouvie-Vief, 1992).

To study this question presupposes an analysis of what the authors understand by "stage". To be able to speak, in a Piagetian perspective, of structural changes, it is necessary to keep in mind the various criteria postulated by this author (Piaget & Inhelder, 1971, p. 121), namely, (a) each stage is characterized by a structure in reference to which the principle individual reactions can be explained; (b) the order of succession of the stages is constant; (c) the structures are integrative: each new structure results from the preceding one, integrating it as a subordinate structure, and prepares the next one by integrating itself into it; and (d) any one stage has a level of preparation and a level of attainment. The passage from an inferior, less general structure to a superior, more general structure presupposes, according to the Piagetian conception, an increase in abstraction. This generalizing abstraction obeys the laws of equilibration, i.e., it reconstructs the operations of the inferior structure into a system that is more balanced, more mobile, and more encompassing. The majority of authors who postulate levels beyond the formal operations are not explicit about what they mean by "stage," or about what criteria the hypothetical fifth stage obeys (see Monnier & Wells, 1980). Some of them have very restricted conceptualizations. For example, Arlin (1984) characterizes the fifth stage of development by the change in the way formal operations are used, which would be manifested as the progressive substitution of "problem solving" by "problem finding."[3] Others, like Kitchener and King (1990) defend a statistical conception of stage, and base their theories on psychometric methods, yet never following "a clearly delineated *a priori* logic of stages" (Commons et al., 1998, p. 245). Commons and colleagues are among those authors of the post-formal movement who have done the most to analyze questions regarding both the nature of stages and the criteria used to evaluate them. In a first phase of their work (Commons, Richards & Kuhn, 1982) they justified the existence of a new stage beyond the formal by the elevated levels of abstraction that in their opinion, were not manifested in formal operations. For Commons et al., in the systematic, metasystematic, paradigmatic and cross-paradigmatic levels (contrary to the level of formal operations), subjects became capable of analyzing and coordinating complex logical systems with each other, creating supersystems of a metatheoretical nature. In theoretical terms, all this suggests that we are in the presence of a conception of abstraction similar to that postulated by Piaget (i.e., reconstruction of the operations of the previous system into a more balanced, more mobile, and more encompassing system). The results obtained by Commons, et al. (1982) confirm such reconstructions relating to the systematic and metasystematic stages. However, these results were not confirmed in studies carried out by various researchers (cf. Demetriou, 1990; Kallio, 1995; Kallio & Helkama, 1991; Kohlberg, 1990). For these authors, systematic operations would be identical to that designated by Piaget as "consolidated formal operations" (i.e., Formal B) and, thus, could not be considered post-formal.

More recently, in an appreciable effort to clarify the central question of what is meant by a stage, Commons et al. (1998) propose a notion of stage based on the hierarchical complexity of tasks and on the performance of subjects as they carry out these tasks. In the authors' words, "the resultant definition of stage is that it is the highest order of hierarchical complexity on which there is successful task performance" (p.238). Such a notion of stage does not presuppose, in the opinion of Commons et al. (1998), the abrupt emergence of the new performance and disappearance of the previous performance; but it does presuppose the organization and transformation of the actions of the previous level, these organizations being characterized both by being new (in the sense that they cannot be carried out by lower-level actions) and by being carried out in a non-arbitrary manner. According to these authors, the results, when evaluated for tasks that are proper to a specific notional domain and are presented according to a hierarchical order of complexity (cf. Commons et al., 1995)--and not for tasks corresponding to diverse notional domains--confirm the sequence that they had postulated and already verified previously.

Clearly, the recent conceptualization and methodology of evaluation proposed by Commons et al. (1998) constitutes a conceptual clarification and a rigorous methodological approach. What is of interest now is to develop studies that empirically validate this new vision of stages and that clarify the question of its sequence. For example, it still remains to be clarified whether the tasks pertaining to the systematic level that were successfully accomplished represent the first stage of post-formal operations, or whether they are no more than the expression of the consolidated formal operations; and, also, whether the metasystematic, paradigmatic and cross-paradigmatic levels represent structural reorganizations of formal operations, or whether they simply expand these operations. Expanding could mean merely the integration of formal operations into more extensive systems, a hypothesis considered by Inhelder and Piaget (1955): "...this general form of equilibrium can be conceived as final to the extent to which it does not change during the life of an individual (although it can be integrated into

[3] It is not confirmed that "problem finding" is specific to a level of development superior to the formal, or that it might not be manifested in the formal stage. When Inhelder and Piaget (1955) speak of the capacity that youngsters come to have to formulate hypotheses, to construct theories and systems, or, further, to elaborate life plans, they show that in formal operations the subjects can display high levels of "problem discovery," According to some authors (Gruber & Vonèche, 1976; Monnier & Wells, 1980), "problem solving" and "problem discovery" constitute two dimensions of formal operational thought.

more extensive systems)." (p. 121). The reorganization of formal operations into higher structural levels presupposes the reconstruction of the operations of the previous structure (and not just of one operation, evaluated by means of one task, and presented with various levels of complexity, such as is proposed by Commons et al. [1998] ) into a more balanced, more mobile, and more encompassing system. The results of Commons et al. (1998) suggest expansion more than reorganization. Be that as it may, further study is necessary, both of a longitudinal (above all) and of a transversal nature, to shed light on this question. Only the results of such studies will allow, or not, for the attribution of a truly structural and "hard stage" (cf. Kohlberg & Armon, 1984) status to post-formal behavior, as it is conceptualized by Commons and his colleagues.

As to the remaining conceptualizations that accent the contextual, self-referent, and pragmatic dimensions and propose a more integrative view of adult behavior, these do not seem to constitute stages beyond the formal operations, but rather developments parallel to formal level. In the words of Labouvie-Vief (1992)), herself an author of the post-formal movement," the term *postformal* may not imply a progression in formal complexity. Instead, it could mean that for some individuals, formal thinking forms a base from which thought branches out into more nonformal domains (p.221)." Along this same line, Kohlberg & Armon (1984), conclude that "soft" stage (in which development is conditioned by particular experiences arising from differences in personality, upbringing, social class, and age) would be the conceptualization more adequate to the particular features of adult development than "hard" stages (in which development occurs in an invariant and universal sequence, e.g., the Piagetian stages). To Gruber (1984), for one, the web of interactions between the adult and the environment is so complex that generalization is difficult, making the existence of a general structure beyond formal operations almost impossible.

Given the heterogeneity of theories and given the inconclusiveness of the research carried out so far, it is not possible, for now, to determine the true nature of the behavior referred to as post-formal. This being the case, and considering that any scientific and epistemological theory must be based on presuppositions such as conceptual clarification, parsimony, and simplicity, it seems preferable to abandon the term "post-formal" stage(s) (except, possibly, in the case of the conceptualization put forth by Commons and coleagues) and to speak simply of adult behavior.

## Some Considerations about the Models of Development underlying Studies of Adult Behavior

Most of the approaches to the post-formal level have common roots in the cognitive-developmental approaches of Piaget and Kohlberg. The major concern of cognitive-developmental psychology has been behavioral change (what develops and in what sequence) and both a general explanation of change and the specific mechanisms that bring it about (see Gruber & Vonèche, 1995). According to the cognitive developmental model (see Gruber & Vonèche, 1995; Lourenço & Machado, 1996) (a) what develops is the general competence to act upon and to think about the physical and logical-mathematical world; (b) this competence is general, structural and organized (stages or structures) and not specific and local; (c) the stages occur universally in a fixed order; (d) the stages are actively and continually constructed by the subject in interaction with the environment; and (e) the major factor in such construction is the equilibrium factor, whose origins go back to biological regulatory mechanisms. Among these claims, the third one, i.e., that there are stages of development that occur in a fixed order, has been the most criticized. One major criticism has been that stages are not subject to any form of empirical verification, but rather constitute a conceptual and *ad hoc* description of sequential changes in human behavior (see Commons et al., 1995; 1998). This fact has led some authors (Broughton, 1984; Gardner, 1985; Miller, 1983) to propose the abandonment of the search for universal stages (Peláez & Gewirtz, 1995). An alternative would be to concentrate on an approach that emphasizes behaviors and actions in context. The behavior-analytical approach to development, found in Skinner's work, (see Peláez-Nogueras & Gewirtz, 1992) (a) explains development in terms of functional interrelation between environmental contingencies and the subject's behavior in context; (b) claims that these interactions are sequential and reciprocal; (c) is contextualistic, holding to the underlying metaphor of the historical act in context; and (d) conceives behavioral development as a continuous process, moment-to-moment, rather than in terms of qualitatively distinct stages.

Although in the cognitive-developmental approach t development implies change that occurs in a certain direction (Chapman, 1998)—a direction understood as toward greater differentiation and integration, better organization, and aiming for higher levels of equilibrium (Youniss, 1995)—and distinguishes the concept of development from change over time, seeing age as merely an indicator and not as a criterion of development, in the behavior-analytical approach, development is conceived of as a sequential accumulation of changes in an arbitrary process in which age, also, is irrelevant. In the words of Gewirtz & Peláez-Nogueras (1992), in this approach "it is difficult to have a reasonable operational concept of development because the specification of those behavior systems whose sequential changes are taken to reflect development is arbitrary (p. 1417)." If in functional terms there seem to exist some points of convergence between these two approaches (e.g. an emphasis on action, the conception of development as interrelation between the subject's behavior and the environment), the great divergence is in the conception of development itself: a unified process of development in the cognitive-developmental approach; sequences that are arbitrary and dependent on variations in context, in the behavior-analytical approach. Faced with some limitations in the cognitive- developmental approach for the study of the adult, several authors questioned whether they ought to exchange the vision of a unified process of development for one in which sequences are more dependant upon variations in context. According to Labouvie-Vief (1992):

> Not all writers on the issue have agreed that we ought to exchange his broad vision of a unified process of development for one that reduces all

individual variability to variations in content or context. Rather, a growing body of work reflects the conviction that a structurally oriented—albeit more contextually open—theory *can* offer an important avenue to understanding adulthood" (p. 197).

Despite opting for a unified conception of development, some adult developmentalists have continued to be confronted with various difficulties raised by the Piagetian cognitive developmental approach, in particular the difficulty—or even impossibility—of empirically verifying the stages. This problem, for example, led Commons and his colleauges to successively review their methodology and to propose alternative models: first the Model of Hierarchical Complexity (Commons et al., 1998), and more recently (Commons & Miller, in press) the Quantitative Behavior Model of Developmental Stage, which is based upon the previous model. According to the authors, the Quantitative Behavior Model of Developmental Stage is a quantitative behavior-model of development that deals both with the sequences of development and with the development that takes place. It is behavioral because it makes only behavioral assumptions and avoids mentalistic explanations, and because it uses principles derived from quantitative analyses of behavior. The aim of these models, centered on task analysis, is to show that stages exist as more than *ad hoc* descriptions of sequential changes in human behavior, and to formalize key notions implicit in most stage theories. Although it is a very recent model in need of some conceptual clarification and more research for validation, it seems that task analysis could contribute to a more unified vision (and consequently a less arbitrary one) of the process of development, and could constitute a good instrument for studying development that would make it possible to clarify the distinctive characteristics of adult development.

This very recent proposal calls to mind the last work of Inhelder and her collaborators in which the focus of study shifted from macro-development to the changes that occur in the spontaneous action sequences of micro-formation (Karmiloff-Smith & Inhelder, 1975). Now the shift is to the changes in the tasks, defined as "sequences of contingencies, each presenting stimuli and requiring a behavior or a sequence of behaviors that must occur in some non-arbitrary fashion" (Commons & Miller, in press).

As to the remaining models, dialectical and relativist, they don't seem to be models of development properly speaking, to the extent that they do not respond to the two main questions dealt with by theories of development, specifically a) what behaviors develop and in what order, and b) why development takes place. Even though they might be considered as such, they don't seem to be a good alternative, or a good complement, to cognitive-developmental theory for two reasons: (a) As stated above, they transpose, in a questionable way, the Einsteinian concept of relativity belonging to physics to the domain of psychology; and (b) Riegel's criticism that Piaget has neglected the dialectical aspects seems to have no foundation. In effect, it is important to note that dialectics plays an important functional role in Piaget's theory. For Piaget, dialectics is a process and not a stage, as Riegel has proposed. Dialectics is the inferential part of equilibration and plays an essential role in the construction of structures (see Morrien & Wells, 1980).

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# The Development of Sexual Arousal Patterns in Humans

## *Implications Arising From the Derived Transformation of Functions*

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*The behavioral approach has offered much to the field of sex research by way of demonstrating the respondent and operant flexibility of human sexual arousal. Nevertheless, social and cognitive theories of sexual arousal development, such as Bems' (1996) Exotic Becomes Erotic theory, have won widespread favor due to several specific shortcomings in behavioral accounts. The present paper briefly reviews these shortcomings and offers a solution by pointing to recent developments in the analysis of derived stimulus relations and the derived transformation of functions. In particular, it is argued that Relational Frame Theory, as one account of derived relational activity, provides opportunities for the significant extension of the behavioral sex research agenda. Moreover, the Relational Frame approach addresses the widespread interest in the role of verbal and social interaction in the development of sexual arousal, and the natural constraints on learning imposed by biology.*

Over the past century, sex researchers from a range of theoretical perspectives have examined an impressive range of human sexual behavior under laboratory conditions. The topics of study might be broadly summarized under the following headings: sexual deviance, sexual identity, sexual attraction, sexual orientation, mating, and sexual arousal patterns. To the behavior analyst, patterns of sexual arousal are perhaps the central component of sexual behavior because such patterns determine the types of objects towards which this behavior is directed (Alford, Plaud, & McNair, 1995). It is likely for this reason that most behavioral sex research to date has concerned the development of patterns of sexual arousal to arbitrary and biologically significant stimuli.

Behavioral accounts of the emergence of sexual arousal patterns are essentially developmental in nature. For instance, a behavioral account of sexual orientation attempts to identify the history of stimulus associations, reinforcement, and social and nonsocial interactions necessary for a given sexual orientation to emerge across time. While no longitudinal behavioral/developmental analysis of human sexual arousal patterns has yet been conducted, important theoretical advances have arisen from laboratory analyses of conditioned sexual arousal (see Alford et al.,1995).

To date, a range of behavioral studies have examined habituation to sexual stimuli (e.g., Koukounas & Over, 1993; O'Donohue & Geer, 1985; O'Donohue & Plaud, 1991), the respondent conditioning of sexual arousal to arbitrary stimuli (e.g., Plaud & Martini, 1999; Rachman, 1966), and the operant conditioning of sexual arousal (e.g., Quinn, Harbison, & McAllister, 1970; Schaefer & Colgan, 1977). A much larger number of studies have examined the treatment of sexual disorders in the clinical setting using such behavioral techniques such as respondent conditioning (e.g., Herman, Barlow, & Agras, 1974; see also Quinsey & Marshall, 1983), stimulus fading (e.g., Barlow & Agras, 1973), covert sensitization (e.g., Barlow, 1993; Barlow, Agras, Leitenberg, & Callahan, 1972), orgasmic reconditioning (e.g., Conrad & Winzce, 1976), and aversive conditioning (e.g., Bancroft, 1974; McConaghy, 1970).

Of course, demonstrating the use of learning principles in the laboratory conditioning of sexual arousal and the treatment of dysfunctional sexual arousal patterns does not serve as conclusive evidence that sexual arousal patterns actually emerge through respondent or operant processes in the world outside the laboratory. Nevertheless, the relative success of behavioral procedures in the treatment of a wide range of sexual paraphilias serves as strong support for a behavioral account of the development of sexual arousal patterns in humans.

Despite real advances in the experimental analysis of sexual arousal, laboratory analogues of the development of sexual arousal patterns have persistently suffered from a series of specific shortcomings. Firstly, laboratory conditioned arousal is relatively weak and quick to extinguish, showing none of the robustness of paraphilias observed in the clinical setting. For this reason, even Rachman, the pioneer of the "laboratory induced fetish.," abandoned hope of developing a full behavioral model of sexual fetishism. Secondly, the operant conditioning of sexual arousal is not an unambiguous effect. Only a limited number of studies have shown the effect and many of these have considerable methodological weaknesses (see O'Donohue & Plaud, 1991). Thirdly, it is often difficult to relate paraphilic arousal to previous learning experiences. Even the eponymous San Francisco study (Bell, Weinberg, & Hammersmith, 1981) failed to find a link between learning experiences and the development of sexual preference across a sample of 1000 homosexual men and women. Consequently, many sex researchers have lost faith in a learning account of sexual arousal patterns (Bem, 1996).

Because of these shortcomings in the behavioral approach to sexual arousal, cognitive and social theories of sexual arousal development have begun to win favor in the sex research literature. Perhaps the most influential of these theories is Daryl Bem's (1996, 2000) *Exotic Becomes Erotic* (EBE) theory. According to EBE theory, genetic, hormonal, and neuroanatomical variables do not code for sexual arousal patterns to specific stimuli (e.g., the opposite sex), but for behavioral temperaments, such as a preference for rough-and-tumble play. Children of a given temperament discriminate themselves as similar to or different from other children of the same or opposite sex. As they develop, children respond to peers of a different temperament as unfamiliar and exotic. In some cases, the exotic others will be of the same sex (as for a child with a sex-atypical temperament), and in other cases, exotic others will be members of the opposite sex (as for a child with sex-typical temperament). Exotic peers serve as novel stimuli that produce non-specific autonomic arousal that is then transformed into erotic arousal over time.

At this point, the behavioral researcher will be in need of several technical definitions of hypothetical process and variables, most notably *transformation*. The process of transformation would appear to be the critical stage in EBE theory, and yet it would appear to be unsupported empirically. Bem draws loosely on a few well established psychological effects (i.e., opponent processes, imprinting, extrinsic arousal effect) to speculate on how the transformation may occur, but concedes that there is no direct evidence for this process. Indeed, Bem suggests that empirical research is needed to identify precisely how an individual viewed as exotic could acquire sexually arousing functions for another individual. As it happens, behavior analysts are already busy developing analyses of how the psychological functions of stimuli are transformed by their participation in verbal relations, and the current author's research in particular has examined this in relation to the transformation of neutral stimuli into sexually arousing stimuli. While several key processes may be involved in the transformation of exotic stimuli into erotic stimuli, recent developments in the experimental analysis of sexual arousal may help fill some of the empirical knowledge gaps in EBE theory, as well as significantly supplement the existing behavioral sex research literature.

## Derived Stimulus Relations and the Transformation of Sexual Arousal Functions

Studying derived stimulus relations often involves explicitly training a number of conditional discriminations among arbitrary stimuli such as: A -> B and B-> C, and then testing for untaught or derived relations, such as symmetry between B and A, C and B, and transitivity between A and C (e.g., Sidman, 1994). Researchers in this area also often investigate what has been called the derived transformation of function, in which a specific behavioral function, such as sexual arousal, is explicitly established for the C stimulus, after which it emerges for the A stimulus (e.g., Roche & Barnes, 1997). This effect is important because it allows the behavioral researcher to explain emotional responses for which there would not appear to be a sufficient history of direct reinforcement or stimulus association. Sexual responses to apparently novel stimuli, for instance, might be traced historically, not to respondent processes or explicit reinforcement for sexual responding, but to the participation of those stimuli in derived relations that themselves contain respondent sexual stimuli or discriminative stimuli for the availability of sexual reinforcement. Several authors have used the transformation of stimulus function effect as a crucial component of a modern behavioral approach to phobia and fear conditioning (e.g., Dougher et al. 1994), sexual arousal patterns to novel stimuli (e.g., Roche & Barnes, 1997; Roche, Barnes-Holmes, Smeets, Barnes-Holmes, & McGeady, 2000), and emotional functioning in general (e.g., Friman, Hayes, & Wilson, 1998).

Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) explains the emergence of derived relations and the derived transformation of function in operant terms. More specifically, RFT takes the position that the ability to derive relations must itself be learned across a large number of relational exemplars. Training across multiple exemplars of derived relations occurs in a variety of social contexts such as parent-child interactions and in educational games. For instance, many children are taught explicitly that the sound of the word "cup" stands for or goes with actual cups. On other occasions, children are also taught to orient toward cups on the production of the sound "cup" by a teacher or parent. In effect, the child is taught the "cup" → *actual cup* relation in two directions. This explicit symmetry training may then occur for hundreds of other sounds and words across time until the effects of training are sufficiently generalized that they can apply to any range of events (i.e., name-object symmetry will emerge between any two stimuli following training in one direction only). Thus, according to RFT, derived relational responding shares all of the important defining features of any operant. Specifically, relational frames develop over time, they are flexible and can be shaped, they can be brought under stimulus control, and they are controlled by their consequences (see Hayes, Barnes-Holmes, & Roche, 2001).

Relational Frame Theory also takes an explicit interest in relations other than equivalence, such as opposite, more than, less than, different, and so on. Each of these relations can be characterized by different patterns of the transformation of function. The characteristic nature of these various patterns is illustrated by a study conducted by Roche et al. (2000). In that study, the contextual functions of SAME and OPPOSITE were established for two arbitrary stimuli using pretraining devised by Steele and Hayes (1991), and these cues were then used to establish a simple relational network in which B1 and C1 were related to A1 through *Sameness*, and B2 and C2 were related to A1 through *Opposite*. Stimulus B1 was then paired directly with sexually arousing material, and during subsequent probe trials, sexually arousing functions emerged for C1 in the presence of the SAME cue, but not in the presence of the OPPOSITE cue. The converse pattern emerged for the C2 stimulus: C2 produced arousal in the presence of the OPPOSITE cue, but not in the presence of the SAME cue. These and related findings extend the transformation of function effect and would appear to demonstrate that highly complex patterns of sexual arousal can now be studied from a behavior-analytic perspective.

A Relational Frame analysis of sexual arousal takes a special interest in the verbal relations that govern sexual behavior. For instance, the verbal statement "weird sexual activity can be really enjoyable" frames the terms "weird" and "enjoyable" in a relation of coordination (or equivalence) such that the functions of the former term are transformed by the functions of the latter. In effect, for the listener, the term "weird" acquires some of the appetitive functions of the term "enjoyable." It is a simple extrapolation from several laboratory demonstrations of the derived transformation of sexual arousal functions that verbal interaction with the wider culture is at least one process by which the functions of sexual stimuli are established, transformed, and maintained.

For the purposes of illustrating a simple RFT analysis of a relatively unusual sexual arousal pattern, the foregoing example can be built out a little further. Let us consider the development of transvestism in a hypothetical scenario. Suppose that a sexually developing young boy hears from friends and peers that some people find "weird" behaviors sexually arousing. The young boy may well not understand the statement and have no reference for the term "weird" in this context. Some time later, however, he may also hear that it is considered "weird" for boys to dress in girls' clothes. Given the foregoing verbal relations, the boy may now respond to a derived relation of coordination between sexual arousal and "dress in girls' clothes" (and equivalent terms). Once this relation is derived, the functions of sexual arousal will transform the functions of cross-dressing for this boy over time such that "cross-dressing" will elicit some of the functions of sexual arousal itself.

Of course, not all boys who are exposed to the foregoing verbal relations will respond to cross-dressing as sexually arousing. Many other competing verbal relations established by the verbal community will lead to incompatible transformations of function (e.g., "boys should not wear girls' clothes"). Thus, it remains an empirical question as to how myriad verbal relations together support the dominance of a particular sexual function for a particular stimulus, event, or activity in a given context. Surely, each case of the development of transvestic arousal will be unique with respect to the relevant social and nonsocial interactions necessary and sufficient to generate that specific arousal pattern. Nevertheless, RFT provides a conceptual framework for understanding how sexual arousal responses might be transformed in accordance with networks of verbal relations established by the verbal community.

A relational frame approach to human sexual behavior also accommodates the study of covert sexual stimuli and the covert transformation of arousal functions resulting from private sexual fantasies. Put simply, RFT does not distinguish, at the level of process, between the transformation of easily observable respondent, discriminative, and reinforcement functions and the transformation of private perceptual functions. So, for instance, a person may experience private perceptual functions of sexual contact by simply reading about sexual interaction, or by making private statements concerning sexual activity. In technical terms, this is possible because of the transformation of printed words or privately stated terms by the functions of the symmetrically related perceptual functions of sexual contact. Indeed, there is no reason why private statements could not form the basis of further derived verbal relations and thus further transformations of sexual arousal functions. In this way, sexual arousal established through observable respondent or operant processes can, at least in principle, be developed and transformed beyond recognition through private verbal behavior (i.e., sexual fantasy). An RFT approach is suited to the analysis of this process in that it uses functional-analytic terms and concepts in the analysis of private sexual fantasy. This ultimately leads to overt sexual arousal patterns which might otherwise appear inexplicable in terms of a traditional learning account (see Roche & Barnes, 1998).

## Natural Constraints on Learning

It would be surprising if there were not some natural constraints placed on the development of sexual arousal patterns by the formal features of stimuli. Surely, many directly conditioned and derived sexual stimulus relations in the world outside the laboratory have some nonarbitrary properties. For instance, sex researchers have long noted that natural selection has favored associations between specific types of stimuli and specific types of responses (see Garcia & Koelling, 1966; Seligman, 1970). In one study (Gosselin & Wilson, 1984), a surprising consistency across stimulus types that form fetish objects for males was found. These objects are typically pink, black, smooth, silky, and shiny. The obvious formal features that all of these objects have in common are those they share with the female genitalia, particularly the vulva. The relative narrowness of the range of fetish objects that are commonly present in the clinical setting and their likeness to what is presumed to be a biologically significant sexual stimulus (i.e., female genitalia) may suggest a biological preparedness for conditioning to such stimuli (McConaghy, 1987).

The relational frame approach to human sexual arousal fully acknowledges that formal similarities between various stimuli will make a wide variety of derived relations more likely to emerge. Thus, although a derived relation between a pink shiny object and the female vulva may in principle emerge from entirely arbitrary relational networks, the physical relationship between them may participate in the very generation of those relational networks. For instance, the fetishist will likely be able to make such statements as "all pink things turn me on," thereby demonstrating the derivation of an overarching verbal relation that now obtains across all pink objects. Such derived verbal relations will thereby lead to the further transformation of functions across participating stimulus events and the strengthening of the sexual functions that adhere for pink objects. By recognizing the subtle interaction between verbal and nonverbal learning processes, therefore, RFT provides a technical account of the emergence of highly complex and unusual sexual arousal patterns that encompasses our knowledge of evolutionary variables, histories of direct stimulus association, instrumental learning, and the role of derived stimulus relations and verbal contingencies.

## Conclusion

In this paper I have focused exclusively on the role of the derived transformation of function in explicating a newly emerging behavioral account of sexual arousal development. However, several important conceptual and empirical questions remain regarding the development of sexual arousal patterns, especially regarding other processes, such as rule governance and the role of setting variables. Ongoing research in the author's laboratory, for instance, has focused on the relationship between biological reinforcement and derived relational responding. Despite several outstanding empirical questions, however, the account presented here essentially represents the beginnings of an analysis of the interaction between social/verbal behavior and the sexual functions of stimuli. To this extent, it provides a scientific basis for the investigation of the increasingly popular idea that modes of discourse aid in the construction and constraint of sexual behavior (e.g., Grosz, 1994). By focusing on the role of verbal contingencies in the production and maintenance of sexual arousal patterns, and by recognizing the role of natural constraints on learning, this approach to the development of human sexual arousal takes some steps forward in the advance of behavioral sex research, and also builds empirical and conceptual bridges to mainstream sex research within our discipline.

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Author's note
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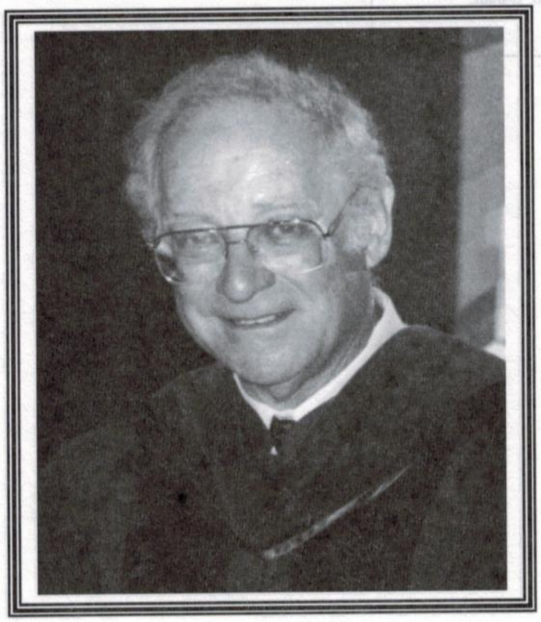
# Age-Irrelevant Contributions to Developmental Science

## *In remembrance of Donald M. Baer*

**OBITUARY**

Edward K. Morris

*University of Kansas*



**Donald M. Baer** -- Roy A. Roberts Distinguished Professor of Human Development and Family Life and of Psychology at the University of Kansas -- died unexpectedly of natural causes at his home in Lawrence, KS on April 28, 2002. He is survived by his wife, Elsie M. Pinkston, Professor of Social Services Administration at the University of Chicago, three daughters from an earlier marriage to Ann Marshall – Ruth, Miriam, and Deborah -- and his brother, Robert.

Don was born in St. Louis, MO, on October 25, 1931, grew up in Chicago, and attended the University of Chicago. In 1950, he received a B.A. with honors from Chicago; in 1957, he earned a doctorate in experimental psychology under the supervision of Jacob L. Gewirtz. At the University of Washington (1957-1965), he began a notable program of research in the experimental analysis of child behavior and, with Sidney W. Bijou, established a behavior-analytic approach to child development. At the University of Kansas (1965-2002), he continued his program of research in behavioral development, but also turned toward applied behavior analysis in the service of atypical developmental outcomes (e.g., developmental disabilities; Baer, Wolf, & Risley, 1968).

Frances Degan Horowitz had established the Department of Human Development and Family Life in 1963. Under her administrative guidance, she and Don, along with Barbara C. Etzel and James A. Sherman, built a program of national stature in behavior analysis, early childhood education, and developmental psychology (Baer, 1993). The Department received many years of continuous training grant funding from the National Institutes of Child Health and Human Development; it received an award from the Society for Research in Child Development for its programs in early childhood; and in 2000, it was the first academic department to receive the award for Enduring Programmatic Contributions to Behavior Analysis from the Society for the Advancement of Behavior Analysis (SABA). Don accepted the award on behalf of the Department's faculty, students, and staff.

Don was not only the acknowledged intellectual leader in the Department, but also an outstanding Senior Scientist in KU's Bureau of Child Research, now the Schiefelbusch Lifespan Institute, where he secured significant federal funding for his research. He published over two hundred and fifty books, journal articles, chapters, book reviews, and commentaries, and made innumerable presentations, many of them seminal and enduring contributions to the behavior analysis of development. Among the conceptual topics he addressed were developmental theory (e.g., Baer, 1976), developmental psychology as a discipline (e.g., Baer & Wright, 1974), the behavior analysis of development (e.g., Bijou & Baer, 1961, 1965, 1978; see also Bijou & Baer, 1967; Midgley & Baer, 1997), interrelations between developmental psychology and behavior analysis (e.g., Morris, Hursh, Winston, Gelfand, Hartmann, Reese, & Baer, 1982), developmental concepts such as ages (Baer, 1970), stages (Rosales-Ruiz & Baer, 1996), structure

(Baer, 1982), and the nature and process of development itself (Baer, 1973; Baer & Rosales-Ruiz, 1998).

Among his empirical contributions were (a) experimental methods and research designs (e.g., Bijou & Baer, 1960, 1964, 1966); (b) the experimental analysis of child behavior, for instance, with respect to establishing operations (e.g., social deprivation; Gewirtz & Baer, 1958a, 1958b; Gewirtz & Baer, & Roth, 1958) and aversive control (e.g., escape and avoidance; Baer, 1960, 1961, 1962a, 1962b); and (c) behavioral analyses and syntheses in such content domains as social development (e.g., Harris, Wolf, & Baer, 1964; Hart, Reynolds, Baer, Brawley, & Harris, 1968), imitation (e.g., Baer & Sherman, 1964), language development and verbal behavior (e.g., Guess, Sailor, Rutherford, & Baer, 1968; Rosenfeld & Baer, 1970), verbal-nonverbal correspondence (e.g., Paniagua & Baer, 1982; Rogers-Warren & Baer, 1976), self-instructions (e.g., Duarte & Baer, 1994; Fjellstrom, Born, & Baer, 1988; Grote, Roslaes, & Baer, 1996; Grote, Rosales, Morrison, Royer, & Baer, 1997), and creativity (e.g., Goetz & Baer, 1973; Holman, Goetz, & Baer, 1977).

And, of course, his analyses of and interventions into atypical development are legion, especially in behavior disorders (e.g., Silverman, Watanabe, Marshall, & Baer, 1984), developmental disabilities and mental retardation (e.g., Warren, Baxter, Anderson, Marshall, & Baer, 1981), early childhood (e.g., Baer, Rowbury, & Goetz, 1976), and education (e.g., Baer & Bushell, 1981; Thomson, Holmberg, & Baer, 1978) -- and in the generalization of intervention outcomes (e.g., Stokes & Baer, 1977). (For reviews, see Baer & Sherman, 1970; Risley & Baer, 1973.)

Don received many awards for these and other contributions, among them the 1987 Don Hake Award from Division 25 (Behavior Analysis) of the American Psychological Association (APA) for work bridging basic and applied research, APA's 1996 Division 33 (Mental Retardation and Developmental Disabilities) Edgar A. Doll Award for his contributions to people with developmental disabilities, and the 1997 award for Distinguished Service to Behavior Analysis from SABA. He also served as president of the Association for Behavior Analysis (1980-1981), associate editor of the *Journal of Experimental Child Psychology* (1964-1967), and a reviewer for numerous developmental and behavioral journals, and international and federal granting agencies. Finally, Don was widely sought after as an internationally distinguished visiting scholar (e.g., Australia, Japan, New Zealand, Norway, Spain); this summer, he was to visit Poland, then later Brazil. Last winter, under the leadership of Professor Emerita Etzel, the Department established a Donald M. Baer Faculty Award. It will be given to a current faculty member whose work in the basic, applied, or conceptual analysis of behavior contributes to our understanding and improvement of human development. Once funded, it will support a half-time graduate research assistant for the recipient.

At the University of Kansas, Don supervised over 100 doctoral dissertations in Developmental and Child Psychology, and served on over 150 master's theses committees in the Department's program in early childhood and behavior analysis. Beloved by his students, Don was honored by them on April 12-14, 2002, with a conference, receptions, and a banquet -- a BaerFest. They celebrated Don's contributions to behavior analysis and developmental psychology, his teaching and mentoring, and his impending retirement in June. Over 100 colleagues traveled from all over the world to be with him -- from Brazil, Japan, New Zealand, and Norway.

Don is remembered for his analytic brilliance and his wit; his high standards for experimental proof; his advocacy on the behalf of individuals with developmental disabilities; his great generosity and good will toward graduate students and junior colleagues; and of course. his timeless, age-irrelevant contributions to developmental science.

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# ANNOUNCEMENTS:

## First Conference of the European Association for Behaviour Analysis

Parma, Italy

***22nd – 25th July, 2003***

Submissions of symposia, papers, posters, and workshops on any aspect of behaviour analysis are welcome.
We especially welcome submissions in the following areas:

- Applied Behaviour Analysis
- Autism and Developmental Disorders
- Basic Learning and Conditioning
- Behavioural Ecology and Animal Cognition
- Behavioural Genetics and Pharmacology
- Education and Precision Teaching
- Verbal Behaviour and Stimulus Classes

Deadline for submission of symposia, papers, posters, and workshops:

***1st December, 2002***

**Registration Fees**

By 30th April, 2003: 100 Euros (60 Euros for students)
After 30th April, 2003: 150 Euros (90 Euros for students)

**Contact: Phil Reed, President of EABA (p.reed@ucl.ac.uk) for further details**

## World Conference on ACT, RFT, and the New Behavioral Psychology

Linkoping, Sweden

**August 13-17, 2003**

Acceptance and Commitment Therapy, and Relational Frame Theory, the theory of language and cognition on which ACT is based, raise philosophical and conceptual issues and new technological alternatives that cast an interesting light on behavioral psychology and its contemporary relevance to problems of human concern. This world conference will draw together clinicians, researchers, scholars, philosophers, educators, and students to consider these issues, to present participants with new developments, to train attendees in the underlying technologies, to examine the growing foundation of data, and to consider the course ahead. The conference welcomes proposals for workshops, symposia, and papers in these topics. For more information on submission and registration visit the following website: *www.swaba.org*

## Behavior Analysis at Florida International University

Formal training in basic and applied behavior analysis is one of the goals of the Department of Psychology and the Department of Educational and Psychological studies at Florida International University. The Department of Psychology currently offers the M.S. degree in Behavior Analysis and the Ph.D. degree in Developmental Psychology with a track in behavior analysis. Research opportunities in this program include 2 infant laboratories, a child phobia center, a learning center, a state hospital and various community facilities for service. Recent research includes studies on exploration of infant learning using conditional discrimination and matching procedures, rule-governed behavior, the treatment of school phobias, an exploration of the conditioned basis of attachment, fear of the dark and fear of strangers in small children, the effects of touch in mother-infant interactions, stimulus equivalence, and language development in early childhood. The Department of Educational Psychology & Special Education (EPSE) offers opportunities for doctoral and masters' degrees in Special Education with a track in Applied Behavior Analysis through several fields/programs including Exceptional Student Education, Community College Teaching, Curriculum and Instruction, and Adult Education and Human Resource Development. Recent research includes studies of social and motor skills among children with severe disabilities, comparisons of error correction procedures used to teach academics, interaction patterns between babies and their depressed-adolescent mothers, and generalization strategies used in parent training programs. The behavioral faculty include Jacob Gewirtz, Martha Peláez, David Bicard, Patricia Barbetta, Wendy Silverman, as well as adjunct faculty Beth Sulzer-Azaroff, Hedi Toro, and Steve Starin. For more information on graduate programs contact Jacob Gewirtz, Department of Psychology, Florida International University, Miami, Fl 33199, phone (305) 348 3375, or Dr. Martha Pelaez, Department of Educational and Psychological studies at (305) 348-2090.

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