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^Ds). 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^Ds 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.

REFERENCES

Allesi, G. (1992). Models of proximate and ultimate causation in psychology. *American Psychologist, 47*, 1359-1370.

Baer, D. M. (1997). Some meanings of antecedent and environmental control. In D. M.

Baer, D. M., & Rosales-Ruiz, J. (1998). In the analysis of behavior, what does "develop" mean? *Mexican Journal of Behavior Analysis, 24*, 127-136.

Berndt, T. J. (1992). *Child development*. Orlando, FL: Harcourt, Brace, Jovanovich.

Bijou, S. W., & Baer, D. M. (19 78). *Behavior analysis of child development*. Englewood Cliffs, NJ: Prentice-Hall.

Blakely, E., & Schlinger, H. D. (1987). Rules: Function-altering contingency-specifying stimuli. *The Behavior Analyst, 10*, 183-187.

Branch, M. N. (1977). On the role of "memory" in the analysis of behavior. *Journal of the Experimental Analysis of Behavior, 28*, 171-179.

DeCasper, A. J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science, 208*, 1174-1176.

DeCasper, A. J., & Prescott, P. A. (1984). Human newborn's perception of male voices: Preference, discrimination, and reinforcing value. *Developmental Psychology, 17*, 481- 491.

DeCasper, A. J., & Sigafoos, A. D. (1983). The intrauterine heartbeat: A potent reinforcer for newborns. *Infant Behavior and Development, 6*, 19-25.

Diamond, J. (1997). *Guns, germs, and steel: The fates of human societies*. New York: W. W. Norton.

Donahoe, J. W., & Palmer, D. C. (1994). *Learning and complex behavior*. Boston: Allyn and Bacon.

Dworetzky, J. P. (1996). *Introduction to child development* (6th ed.). St.Paul/Minneapolis: West.

Etzel, B. (1997). Environmental approaches to the development of conceptual behavior. In D. M. Baer and E. M. Pinkston (Eds.) *Environment and behavior*. Boulder, CO: Westview Press.

Gewirtz, J. L. (1972). Attachment, dependence, and a distinction in terms of stimulus control. In J. L. Gewirtz (Ed.), *Attachment and dependency*. Washington, DC: Winston.

Gewirtz, J. L., & Peláez-Nogueras, M. (1991). The attachment metaphor and the conditioning of infant separation protests. In J. L. Gewirtz & W. M. Kurtines (Eds.), Intersections with attachment (pp. 123-144). Hillsdale, NJ: Erlbaum.

Gewirtz, J. L., & Peláez-Nogueras, M. (1992). Infant social referencing as a learned process. In S. Feinman (Ed.), Social referencing and the social construction of reality in infancy (pp. 151-173). New York: Plenum.

Grobstein, C. (1988). *Science and the unborn*. New York: Basic Books.

Lipsitt, L. P. (1981). Sensorimotor development: What infants do and how we think about what they do. In D. M. Brodzinsky, I. E. Sigel, & R. M. Golinkoff (Eds.), *New directions in Piagetian research and theory*. Hillsdale, NJ: Erlbaum.

Machado, A., Lourenço, O., & Silva, F. J. (2000). Facts, concepts, and theories: The shape of psychology's epistemic triangle. *Behavior and Philosophy, 28*, 1-40.

Mayr, E. (1997). *This is biology: The science of the living world*. Cambridge, MA.: Belknap Press.

Morris, E. K. (1988). Contextualism: The world view of behavior analysis. *Journal of Experimental Child Psychology, 46*, 289-323.

Morris, E. K. (1998). Mechanism, contextualism, and the behavior analysis of development. *Mexican Journal of Behavior Analysis, 24*, 97-110.

Morris, E. K., Higgins, S. T., & Bickel, W. K. (1982). Comments on cognitive science in the experimental analysis of behavior. *The Behavior Analyst*, 5, 109-125.

Palmer, D. C. (1991). A behavioral interpretation of memory. In L. J. Hayes and P. N. Chase (Eds.) *Dialogues on verbal behavior (pp. 261-279)*. Reno, NV: Context Press.

Palmer, D. C. (in press). Cognition. In K. A. Lattal & P. N. Chase (Eds.), *Behavior theory and philosophy*. New York: Kluwer Academic Press.

Palmer, D. C., & Donahoe, J. W. (1992). Essentialism and selectionism in cognitive science and behavior analysis, *American Psychologist, 47*, 1344-1358.

Peláez, M. (2002). Causes of Behavior Development and Contextual Variables. Behavior Development Bulletin, 12-19.

Reese, H. W. (1991). Contextualism and developmental psychology. In H. W. Reese (Ed.) *Advances in Child Development and Behavior (Vol. 23)*, New York: Academic Press.

Schlinger, H. D. (1992). Theory in behavior analysis: An application to child-development. *American Psychologist, 47*, 1396-1410.

Schlinger, H. D. (1993). Learned expectancies are not adequate scientific explanations. *American Psychologist, 47*, 1155-1156.

Schlinger, H. D. (1995). *A behavior analytic view of child development*. New York: Plenum.

Schlinger, H., & Blakely, E. (1987). Function-altering effects of contingency- specifying stimuli. *The Behavior Analyst, 10*, 41-45.

Schlinger, H. D., & Blakely, E. (1994). A descriptive taxonomy of environmental operations and its implications for behavior analysis. *The Behavior Analyst, 17*, 43-57.

Skinner, B. F. (1938). *The behavior of organisms.* Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1974). *About behaviorism.* New York: Knopf.

Zeiler, M. D. (1986). Behavioral units: A historical introduction. In T. Thompson & M. D. Zeiler (Eds.), *Analysis and integration of behavioral units* (pp. 1-12), Hillsdale, NJ: Erlbaum.

Author's Note
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