3

The Context of Stimulus Control in Behavior Analysis

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Some behavior researchers are no longer satisfied that the study of simple cause-and-effect relationships between objectively observable dependent and independent variables is sufficient for understanding behavior development. When the putative controlling variables are kept constant, prediction often is very good. But most of the time we do not know the proximate controlling variables, much less have the ability to keep them constant. There has been increasing evidence that the effectiveness and function of a stimulus in controlling an individual's behavior (by evoking or reinforcing it) depend on the contextual interacting variables, including the current and historical, the organismic-biological, and the environmental-ecological.

Linear Causality Versus Interactionism

The typical view of causality in mother-child studies, particularly in controlled laboratory experiments, has been linear. We have been interested in determining whether the behavior of the mother is a proximal cause of the child's behavior (see Gewirtz & Peláez-Nogueras, 1992b, for a review of operant studies in infancy). At other times, we have asked whether the behavior of the child is a proximal cause of the mother's behavior (Gewirtz & Boyd, 1977). Now we analyze the behavior of the mother and the behavior of the child, not only as concurrent influences on each other, but also as functions of the context in which these behaviors are embedded (e.g., Peláez-Nogueras, 1989). Linear causality models (Rapoport, 1968) and traditional research methods have defined causality in terms of a linear relationship between antecedent stimuli, behavior, and consequent events. A more accurate understanding 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 various contextual variables involved can create multiple patterns of functional relations in the antecedent, discriminative, and reinforcing stimuli operating. The traditional methods in basic and applied research ordinarily do not take these multiple interrelated influences into account.

This is not an argument against laboratory or experimental research. Perhaps the most reliable knowledge resulting from any study is an experimental demonstration of cause and effect. We have conducted a great deal of basic research in the laboratory controlling for the behavior of mothers and their infants in contrived settings, and we know this type of research is fruitful, although it has limitations.

Our argument is against noncontextual accounts of human behavior. When we control for initial or boundary environmental or biological conditions and demonstrate that some variable causes changes in some behavior, our understanding of behavior development remains incomplete. The cause of the behavior change observed depends on the multiple interacting variables involved. Our goal should be to expand behavior-analytic methods by moving into both descriptive and functional analyses of the contextual determinants of behavior.

Stimulus Function Derives from Its Context

Morris (1988) has emphasized that "the function of behavior emerges from an ever-changing context" (p. 309). To understand behavior, its function (i.e., meaning or purpose) must be known. To attain this knowledge, the organization of interrelated stimuli and responses in context must be discovered (Kantor, 1933; Morris, 1992; Skinner, 1931, 1935). In addition to altering the efficacy of discriminative and reinforcing stimuli, therefore, the contextual variables also determine the functionality (and directionality) of stimulus effects (e.g., whether a stimulus would function as a positive reinforcer or punitive event). Hence, contextual variables not only inflect behavior and the various antecedent and concurrent variables affecting it, but also affect the interplay between reciprocal interactions among stimuli and response functions in context. Because they interact reciprocally with behavior, these variables can be seen to alter the functional relations within the three-term contingency. Perhaps this is one reason many behavior scientists are analyzing the three-term contingency in interaction with context. Indeed, the probability of behavior change denoting learning 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, 1996; Bijou & Baer, 1978), "state" and "potentiating" variables (Goldiamond & Dyrud, 1967), "contextual determinants" (Gewirtz, 1972; Morris, 1988), and "establishing operations" (Michael, 1982, 1993).

Rather than held constant, the historical and current context should be subjected to experimental analysis (Morris, 1988, 1992). Knowledge of species-typic boundaries and preparedness in biological structure-vulnerability and behavioral function, as well as of individual-typic boundaries and preparedness in biological and behavioral form and function, is fundamental for completely analytic research.

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.

Controlling for Initial Boundary Conditions

Behavior analysts, whenever possible, try to ensure that the potential sources of variability are kept constant. For some, initial boundary factors or conditions (e.g., level of deprivation, reinforcement history) are not cited as components of the laws of behavior (e.g., reinforcement); they only provide the context for interpretation of those laws. Marr (1993a) said that "initial and boundary factors define and set the limits under which a given law will apply . . . they provide a frame of reference to assess those laws" (p. 62). This position may overrule the dynamic role of these variables as interacting variables.

Contextual variables are not restricted to static boundary or initial conditions. They are "interactants," to borrow a term from Oyama (1985). We use the term *contextual interactants* to stand generically for all developmentally relevant factors, rather than 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. Even so, we should be cautious, because all such terms may carry considerable explanatory burden in an interpretive account (Marr, 1993a). For this reason, we restrict the use of the term 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.

Our view of context is not limited to conditions that facilitate or constrain the efficacy of reinforcing stimuli or to momentary effects. Contextual interactants produce relatively stable behavioral changes as a result of their reciprocal interaction with the organism and with the contingencies affecting its behavior. These variables are not static; they are continuously interacting with the organism's behavior as well as with other environmental variables.

In the last decade, new behavioral principles have emerged that describe the role of contextual stimuli in emergent behavior: for example, Sidman's (1986) work on stimulus equivalence and emergent verbal classes, and Hayes's (1991) relational-frames theory. It is conceivable that these new principles can be integrated effectively into the system of principles that compose behavior-analytic theory (Shull & Lawrence, 1993, p. 243).

Expanding Behavior-Analytic Methods

We see an overriding problem in traditional behavior-analytic research. In the experimental analysis of animal behavior, the typical procedure has been to consider

the initial contextual conditions (e.g., food deprivation, animal's history of reinforcement) as a potential source of behavior variation and to hold these conditions constant. In doing so, the researcher has assumed the removal of effects of these boundary conditions from the contingency manipulations, thereby constraining behavior variability. Today, however, behavior analysts can consider chaotic systems (Marr, in press). A *chaotic system* is defined as one that shows sensitivity to initial boundary conditions. That is, any uncertainty in the initial state of the given system, no matter how small, will lead to rapidly growing errors in any effort to predict future behavior. Behavior is sensitive to any minimal change in initial conditions. In human behavior development, it is precisely the multidirectionality of behavior and its variability, within and between individuals, that is of most interest. Behavior that shows stability may be easy to predict, but behavior without variability often cannot be well understood.

Context in the Study of Dyadic Interactions

If contextual determinants of stimulus function are to be investigated, some departures from the traditional methods may be necessary. Wahler and Fox (1981) have proposed departures centered on at least three features: (a) the measurement unit (global entities monitored through molar units of measurement), (b) the temporal relationships among the unit of study, and (c) modes of analysis other than experimental. Their research moves toward conceptual and methodological expansion in the study of contextual variables in applied behavior analysis.

For the behavior-analytic researchers studying human dyads (pairs), it is axiomatic that a response of the first of two actors that routinely follows a recurring response of the second actor can constitute a reinforcement contingency for the second actor's response if that response increases systematically in rate. 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 arises in the study of spontaneous dyadic interactions: In the parent-infant case, for instance, the identity and topography of response elements of the set of turn-taking responses (e.g., smiles, touches, vocalizations, turning away) of each member of the dyad can change at every turn in the series. For this reason, behavior-analytic researchers studying the effects of reinforcement contingencies on behavior preferred, until recently, to study the flow of influence in such interaction sequences in experimentally contrived settings, where no manipulation of the contextual variables was systematically implemented and tested.

In mother-infant dyadic interactions, therefore, the turn-taking response of one dyad member (typically the mother) was controlled or manipulated, whereas the infant's response that provides the dependent variable was left free to vary (e.g., Gewirtz & Peláez-Nogueras, 1991, 1992a; Peláez-Nogueras, 1989; 1992; Peláez-Nogueras, Field, Hossain, & Pickens, 1996; Peláez-Nogueras, Gewirtz, et al., 1996; Poulson, 1983). Infant-mother interactions also can be analyzed in

natural interaction settings without resorting to a limiting experimental procedure as in the studies cited. 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, 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.

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 behavior interaction (Sackett, 1979). These tools for identifying *functional* relations among large numbers of responses in interaction pose difficult problems, however. These methods are not optimally conducive to translating the contingencies implied into reinforcement effects; this is because at every turn in the interaction sequence, a dyad member can emit different behavior combinations; different numbers of responses can occur concurrently; and a particular dyad member's behavior might occur intermittently or infrequently. The behavior-analytic researcher therefore may have difficulty isolating the functional relations involved. In the past, these complications led many behavior researchers, like ourselves, 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 that *context* 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).

A taxonomy of current and historical, phylogenetic and ontogenetic, and biological-organismic and environmental-ecological contextual variables, in terms of form and function of context, has been outlined in detail by Morris (1992; Morris & Midgley, 1990). Earlier researchers have provided a classification of contextual qualifiers (Gewirtz, 1972), setting events (Bijou, 1996; Bijou & Baer, 1961), and establishing operations (Michael, 1982). In what follows, we elaborate on these contextual taxonomies and highlight several studies, mainly from the infancy literature, that may illustrate the function of the contextual variables.

Some Research Examples with Infant Learning

In early intervention programs for infants of depressed mothers, the infants' nursery teachers were trained to promote positive interactions between the mothers and their infants (Peláez-Nogueras, Field, Cigales, Gonzalez, & Clasky, 1994). Depressed mothers who were typically unresponsive to their infants' cues were trained, for instance, to use an attention-getting procedure and to elicit (or evoke) and respond contingently to their infants' initiations of particular behaviors. On the other hand, depressed mothers who showed an intrusive overstimulating behavior pattern were trained to decrease the amount and degree of stimulation and the contingencies they provided their infants through imitation (Malphurs et al., in press).

Mothers learned to regulate their own behavior and also detect the behavioral cues that their infant emitted during the interaction. One such cue for the mother was the infant's state on the arousal dimension (Odom & Haring, 1994), ranging from deep sleep at the low end, active alert in the middle, to high arousal at the high end, as assessed by the Carolina Record of Individual Behavior or the Brazelton Neonatal Behavior Assessment (Brazelton, 1973). If a mother were to initiate an action when the infant was at either end of the arousal continuum, it would be unlikely that the infant would 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. More important, the infant's state of arousal may change during the interaction; in that case, the mother adjusts the quality, timing, and intensity of the signaling and reinforcing stimulation provided. The interaction is a dynamic, ever-changing process, as it is in real-life settings.

Our main point is that earlier experience is a contextual interactant that 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 & Prescott, 1984; DeCasper & Sigafoos, 1983; DeCasper & Spence, 1986). Similar work in the area of memory and remembering has been done by Rovee-Collier and associates (e.g., Rovee-Collier, Griesler, & Earley, 1985). In the DeCasper studies, for instance, 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: 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 a stranger's voice to which the infant was never exposed (Spence & DeCasper, 1987). These studies indicate that in-utero auditory experience can affect postnatal behavior and learning in human neonates.

In the area of infant socioemotional 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. We (Gewirtz & 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 evaluate nonsensical, originally arbitrary, maternal expressions. The results of that study suggested 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 usefulness in such a context.

Two experiments conducted in our laboratory to study mother-infant attachment (Gewirtz & Peláez-Nogueras, 1991; Peláez-Nogueras, 1989) demonstrated that infant protests can come under the close control of discriminative stimuli and reinforcement contingencies generated by a mother's behaviors during her departures and brief separations from her child. By changing the cues and contingencies provided by the mother in the two different sequential contexts (departure and separation), we were able to demonstrate learned discriminations by showing that infant protests were conditioned to contextual variables in addition to maternal cues and contingencies.

The infants learned to respond differentially between the contexts of maternal departures and maternal separations. That is, in one condition their protests were conditioned during their mothers' departures, and they learned behavior alternatives to protesting 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, but to protest 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, and they 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), to denote security or insecurity of "attachment" for Ainsworth and Wittig (1969), and to denote "separation anxiety" for Kagan, Kearsley, and Zelazo (1978).

A behavior-analytic approach to development calls for an analysis of stimulus structure and functions, response structure and functions, their interchange at a particular moment, 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 as well as in 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. Learning operations, therefore, can focus those contextual-environmental factors that can inflect the course of human development.

Contextual Interactants Can Change Stimulus Function

There remains an empirical question at successive developmental points: Which of the myriad potential stimuli function as discriminative stimuli for behavior? Over the years, research has proceeded most fruitfully using the definition of *discriminative stimulus* within the frame of the three-term contingency. Problems arise, however, when discriminative stimuli are not identified as stimuli or related to particular responses in specific contexts. This possibility has led to publication of lists of discriminative stimuli in the literature, with the implication that any of the events is likely to function as a discriminative stimulus for any behavior unit (response) in any context. But the operant-learning paradigm has a clear corollary: A stimulus that functions as a discriminative stimulus for a particular response of an individual in a given context need not function as a discriminative stimulus for a different response in the same context, for the same response in a different context, or for the same response of a different individual in the same or a different context. An organism's responses are functionally related to the controlling stimuli, and no comprehensive empirical account of behavior and its development can be attained if the relations among stimuli, responses, and contextual variables are not delineated.

As the infant's repertoire increases and becomes more complex (owing to maturational-organismic processes and changes in socialization practices), some of these potential discriminative and reinforcing stimuli may drop out and 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 changes 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 change occurs in restricted settings in which the parent's cues (e.g., 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 caused by early neonatal stimulus-response interactions.

A New Stage of Behavior Analysis

We have noted that, in the behavior analysis of development, changes in the dependent variable (e.g., response frequency) may be difficult to understand outside

he network of contextual interactants. In the past, several behavior theorists have ecognized that the reinforcement relationship is contextually determined (e.g., 3ijou & Baer, 1978; Gewirtz, 1972; Kantor, 1933; Michael, 1982; Morris, 1988; Skinner, 1938). Not until recent years have researchers begun to develop explicit programs of research to demonstrate the effectiveness of a contextualistic approach to behavior development (see Morris & Midgley, 1990, for a review of such research programs).

The inherent contextualism of behavior analysis can be identified in various research programs in basic and applied research. Some recent work has improved our principle-based understanding of contextual interactants with behavior, thereby moving behavior analysis beyond the mere analysis of the components of Skinner's three-term contingency. Today, researchers are interested in more than controlling Skinner's "third variables" (or initial-boundary conditions like food deprivation). They are, in addition, investigating the transactional and dynamic nature of those relationships (e.g., Keehn, 1980).

New approaches and research methods have revealed previously unsuspected effects of manipulating context. For instance, Wanchisen and Tatham (1991) exemplified how studies of historical effects can lend insight into human-nonhuman differences and similarities. They noted that after a particular schedule history, the subsequent fixed-interval behavior patterns of nonhumans were strikingly similar to those of humans. If a particular history can be "the great equalizer," these researchers argued, then perhaps a better way to compare human and nonhuman behavior on schedules of reinforcement is through providing similar and different experimental histories before introducing the target contingency. In cases of similar experimental histories, any behavioral discrepancies in performance noted on the targeted contingency could be explored more fully instead of being attributed to humans' extralaboratory histories. The studies by Wanchisen suggest that historical context is an important contextual determinant of behavior and learning.

New principles are emerging that describe the various effects of contextual stimuli as a result of their participation in simple and higher order contingencies. In some cases, the new principles can be integrated effectively into the system of principles that compose behavior-analytic theory, for example, stimulus equivalence (e.g., Sidman, 1986), functional equivalence (e.g., Dougher & Markham, 1994), and relational-frame theory (Hayes, 1991). Increasingly, behavior analysts are interested in constructing a conceptual taxonomy of environmental events that could affect the behavior to be modified (e.g., Schlinger & Blakely, 1994) and the motivational functions of stimuli (Michael, 1991).

In the area of verbal behavior, Dougher (1993) proposed the use of hermeneutic, or interpretive, research methods in the contextualistic analysis of verbal interactions. Unlike hermeneutics advocates, however, he observed the following:

> Contextualism does not and should not avoid experimentation as a method. . . . From a contextualistic perspective, experiments are not qualitatively different from naturalistic investigations; they differ only in terms of their degree of complexity. The pragmatic approach is to use experiments when they are useful and naturalistic/interpretive approaches when they are useful. . . . If one is interested in verbal behavior as it occurs in interpersonal settings, interpretive methods seem to be the way to go. (p. 218)

To behavior analysts who rely only on experimentation to understand behavior, the results of interpretive methods might seem speculative and subjective. However, knowledge obtained from experimentation is no different from any other knowledge; results from experimental methods require as much interpretation as any other kind of data (Dougher, 1993). Whether interpretive, narrative, or descriptive, new research techniques that focus on understanding the relation between behavior and its contexts seem consistent and could be used within the field of behavior analysis. Descriptive and interpretive methods allow researchers to identify variables that predict behavior.

Conclusion

The main assumption underlying the present chapter has been that behavior change does not depend solely or straightforwardly on the standard behavioral concepts and principles (e.g., reinforcement, stimulus control) and operations (e.g., reinforcing and evoking stimuli). We emphasized that both contingencies and contextual interactants (historical and concurrent) play primary roles in the prediction, control, and understanding of behavior change. Consequently, the probability of an individual's learning at a given developmental point varies not only as a function of reinforcement (or punishment), but also as a function of the historical and contemporaneous contextual variables interacting.

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 are indispensable for a proper analysis of the effects of stimulus control on behavior change. By identifying these variables in descriptive analyses, including them in functional analyses (by controlling reinforcing contingencies and manipulating context), or conducting frequency analyses, sequential analyses, or any other method of analysis, researchers may be better able to 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 that could lead us to a greater understanding of human behavior development than has been achieved thus far. Perhaps the growth that has taken place in behavior analysis within the last decade suggests that behavior-analytic theory is undergoing a paradigm shift. It may be moving to a new stage, in which adventurous researchers wish to contribute toward solving everyday practical problems and toward a greater understanding of human interactions.

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4

Verbal-Nonverbal Correspondence Training as a Case of Environmental Antecedents

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Evolution of Correspondence Training

When people make a report about past or future behavior and then behave a cording to that report, the resulting relationship is termed *verbal-nonverbal corr spondence* (Israel, 1978; Paniagua, 1990). In 1968, Risley and Hart provided t first convincing experimental analysis of verbal-nonverbal correspondence trai ing during which children learned that edible reinforcers were available only they engaged in an experimenter-selected behavior (e.g., playing with blocks) a then reported on this (nonverbal) behavior after a brief observation period duri which playing was expected to occur.

Over the years, the original experimental format reported by Risley and Ha received many replications (e.g., Paniagua & Baer, 1982; Rogers-Warren & Ba 1976). There were also transformations, in which the reinforcer was presente contingent on a promise about future behavior and on the actual behavior (De con & Konarski, 1987; Israel, 1973)—showing the reinforcer immediately after promise and giving it after the promised nonverbal behavior (Israel & O'Lear 1973; Paniagua & Baer, 1982). Another method was direct reinforcement of i termediate behaviors occurring between a promise and the corresponding beha iors (Paniagua, Stella, Holt, Baer, & Etzel, 1982). Still another was showing t reinforcer immediately after a series of intermediate behaviors and giving it aft the actual promised behavior (Paniagua & Baer, 1982). The usefulness of the verbal-nonverbal correspondence training procedures has also been reported i the development of prosocial behaviors (e.g., Guevremont, Osnes, & Stoke 1986; Paniagua, 1985; Rogers-Warren & Baer, 1976) and the reduction of prob lematic behaviors (e.g., Paniagua, 1992).

Explanations of Verbal-Nonverbal Correspondence Training

I comment here on four different but not exclusive levels of explanation regardin the function of verbal-nonverbal correspondence training as a case of behavior