MULTIPLE INFLUENCES IN BEHAVIORAL INTERACTIONS

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In this paper I identify different types of organism-environment interactions, discuss major problems with linear causality models, and suggest we should abandon the tactics of controlling for interacting variables (e.g., initial conditions) in developmental research. I emphasize, in particular, the multiple influences involved in behavioral interactions that involve context, both organismic and environmental context. I provide some illustrations of the role of contextual variables in mother-infant interactions.

Views of Organism-Environment Interactions

Let me first discuss three contrasting views of organism-environment interaction that have been identified in the developmental literature. At one level, the *organism-environment interaction* is viewed as similar to environmental contingencies producing different effects on different individuals. That is, in natural uncontrolled environments "there are diverse ways in which similar sets of experiences can give rise to different consequences according to the characteristics of the individual" (Rutter & Pickles, 1994, p. 129-130). This view of interaction is in the statistical sense (Rutter, 1983), where the organism-environment interaction refers to the "differential reactivity by different individuals to similar environmental stimulation (Wachs & Plomin, 1994). A differential reactivity of different individuals is not necessarily due to genetic transmission or individual characteristics/traits. It can be a function of prior environmental history of contingencies and nongenetic biological factors. A second view of organism-environment interactions, as identified by Wachs and Plomin (1994, p.2), is known as *organism-environment covariance.* It refers to "the process by which children with different characteristics either actively or reactively elicit and evoke different types of responses from the environment, thus creating a covariance between the responses of the environment and the child's characteristics" (also Plomin, DeFries & Loehlin, 1977). A third level of organism-environment interaction involves *transaction*. Like interaction, the term transaction has multiple meanings. Transaction often refers to the developmental interrelationship between child and environment, with the child influencing its environment and simultaneously the environment influencing the child. In the behavior-analytic meaning of transaction, the stimulus and response functions (not the form of behavior) simultaneously change. The change in function should not be seen as occurring in a chain, or in back and forth effects– this would be mechanistic. But the change should be seen as occurring simultaneously. Thus, in transactions, an interaction takes place among constantly changing stimuli and responses. Therefore, interaction as transaction is not the same as interaction as differential reactivity.

In uncontrolled natural transactions an interplay between organism and its environment takes place. In mainstream developmental psychology, when transaction research moves beyond main effects, both statistical interactions and correlations are often considered to evaluate the interplay between organismic variables and environmental variables. In basic experimental analysis of behavior, however, we rarely go beyond linear causal analysis where interacting variables are kept constant (e.g., deprivation, organism's history of reinforcement and extinction).

Limitations of Linear Causality Models

Major limitations exist with linear causality models (Rapoport, 1968) and with the traditional research methods that 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 metatheoretical models, precludes an understanding of the transactive variables responsible for behavior development.

In controlled basic experimental research, the typical view of causality has been linear. For instance, in our own laboratories we have been studying whether the behavior of mothers, as cues and consequences, provides the proximal causes of changes in the behavior of infants. Also, under the assumption of a linear model, the behavior of the infant has been manipulated to determine whether it affects systematically (or is the proximal cause of) the behavior of the mother (e.g., Gewirtz & Boyd, 1977). Thus far, however, this type of methodology in studying dyadic interactions, although very useful, is still limited. The ideal analysis of social interactions, should look at, not only the unidirectional influence from one member of the dyad to another, or at their bidirectional influence, but at the role of contextual variables influencing the ongoing interaction.

If one could move into the analysis of the behavior of the members of a dyad, not only as concurrent influences on one another, but also as a function of the context within which the behaviors are embedded, we would have a better understanding of behavioral development (e.g., Peláez-Nogueras, 1994). This type of analysis is yet to be seen within behavior analysis. Developmental behavior analysts like me, studying social interactions, seem to be no longer satisfied that the study of simple linear cause-and-effect relationships between objectively observable dependent and independent variables; this seems insufficient for understanding behavioral development. Often, when the putative interacting variables are kept constant, prediction and control are achieved. However, in social interactions, most of the time we do not know the proximate controlling variables, and much less have the ability to keep them constant. Moreover, there has been increasing evidence in the behavioral literature that the effectiveness and the function of a stimulus in evoking or reinforcing a person's behavior

depends upon the contextual interacting variables. As I will detail next, these variables include current and historical, organismic/biological and ecological variables.

Our traditional methods in basic and applied research ordinarily do not take multiple interrelated influences/variables into account. Skinner (1953) recognized this problem when he asserted:

> A common source of misunderstanding is the neglect of what happens when variables are combined in different ways. Although the functional analysis begins with relatively isolated relations, an important part of its task is to show how its variables interact. (p. 205)

A natural science of behavioral development, however, faces the challenge that the function of behavior of developing individuals is changing continuously and the individuals biological ontogeny and its multiple context of influence are simultaneously changing.

Contextual Interacting Variables: A Brief Review

Contextual variables not only inflect behavior and the various antecedent and concurrent variables affecting it (e.g., inhibitory and facilitatory mechanisms), but also affect the interplay between interactions among stimuli and response functions. That is, contextual variables not only enhance the efficacy of a particular discriminative and reinforcing stimuli but also determine their function and directionality, that is, whether a particular stimulus would function as positive reinforcer, a punitive event, or something else (Peláez-Nogueras & Gewirtz, in press). There are potential multiple effects of a single variable. As Skinner (1953) asserted:

> Because multiple variables interact reciprocally with behavior, they might alter the functional relations within the three-term contingency. That is, 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 the contextual variables involved (e.g., the child's anatomy and physiology including deprivation, illness, fatigue, drug effects, behavior state, the environment including physical ecology, and the changes and variability in both, child and environment). Thus a more complete understanding of behavior development requires an analysis of the relation between the three-term contingency and the interrelated contextual variables (Peláez-Nogueras, 1994).

Morris (1988, 1992) has suggested that rather than take context as a source of variation and hold it constant–which has been the typical operation within behavior analysis–the historical and current context should be a subject matter for experimental analysis. In his view, contextual variables should be addressed as a conceptual category in their own right or formally integrated into the three-term contingency unit of analysis. This type of analysis adheres to a codefinition, in which neither responses nor stimuli have psychological definition by themselves. Rather, their meanings and functions stem from the interdependent relationship between environment and organism, that is, between stimulus and response functions in interactive context. An individual's behavior does not interact merely with the stimulus events comprising the environment in a unidirectional, linear, or reactive manner. Instead, the behavior and environment transact with one another. In transactions, a strong reciprocal interaction takes place among constantly changing stimuli and responses.

Conducting functional analyses that take into account the role of these variables presents a major challenge to behavior analysts, in particular, to those interested in studying social interactions. This is because once we identify the influence of various participating variables in the three-term contingency, *multiple patterns* of functional relations and *multiple directions* can be detected. Perhaps, this difficulty is one of the reasons why our traditional methods in basic and applied behavior analysis ordinarily have not taken multiple interrelated contextual variables into account. As I indicated earlier, more and more behavior analysts are beginning to study interactions and to sample, analyze, and manipulate contextual variables.

Multiple Influences in Mother-Infant Interactions

One feature of the social interaction is the potential bidirectionality of reinforcement effects–each actor's behavior is influenced by the behavior of the other. A problem in the study of uncontrolled social interactions, for instance, in the mother-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) 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 have preferred to study the flow of influence in such interactions in experimental settings where no manipulation of the contextual variables is systematically implemented and tested.

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, 1992; Peláez-Nogueras, 1992; Peláez-Nogueras et al., 1996a; 1996b; Poulson, 1983). Behavior analysts have also recorded the behavior-units 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). But mother-infant interactions also can be analyzed in natural interaction settings without contriving the settings or using experimental procedures as above. We can make predictions and interpretations without experimental determinations. That is, by calculating 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., by stratifying for contextual functions).

Other experimental approaches may also be used. For example, in intervention programs with infants of depressed mothers, we trained caregivers to promote positive interactions with their infants (Malphurs et al., 1996a; Malphurs et al., 1996b Peláez-Nogueras et al., 1994; Peláez-Nogueras, et al. 1996a). First we identified the behavior patterns of the depressed mothers either as *withdrawn* (low levels of noncontingent stimulation) or *intrusive* (high levels of noncontingent stimulation). Depressed mothers who were identified as withdrawn and unresponsive to their infants' cues were trained to use an *attention-getting* procedure and to evoke and respond contingently to their infants' behavioral initiations. In contrast, depressed mothers, who showed an intrusive overstimulating behavioral pattern, were trained to decrease the amount and degree of stimulation and the contingencies they provide their infants via an *imitation* procedure (Malphurs et al., 1996). That is, we trained the mothers to regulate their own behavior and to detect the behavioral cues that their infants emit during the interaction.

In mother-infant interactions, infant behavior state is increasingly recognized as an important organismic contextual variable influencing learning. One cue for the mother is the infant's state of arousal on the dimension 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 were to initiate an action when the infant is at either end of the arousal continuum, it would be unlikely that the infant would respond positively. Following training, a mother can readily detect these states following and regulate her behavior accordingly. Hence, the infant's behavior state is an intrachild variable denoted by the infant's overt actions that set the context for the next interaction. But more importantly, the infant's state of arousal may change during the interaction. Then, a mother may adjust the quality, timing, and intensity of the signaling and reinforcing stimulation provided. The interaction is an ever-changing process–as it is in real life settings.

Multiple Interactions

Multiple interactions have been studied using other methods. 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. Multiple interactions can produce complex nonlinear organism-environment trajectories. The method of sequential analysis of dyadic responses is not optimally conducive to translating the contingencies implied into reinforcement effects 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. The behavior-analytic researcher may have difficulty isolating the functional relations involved. This is why, 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. Even so, this type of research has been very effective for identifying reinforcing contingencies involved in infant learning.

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 moment, and the sequences of such interactions across successive moments. I have emphasized that 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. But more importantly, behavior analysts should be interested in determining how the contextual variables alter these interactions and change the function of stimuli and responses.

Descriptive, correlational, and interpretive methods allow us to identify variables that may influence behavior. Whether interpretive, narrative, or descriptive methodologies, new research techniques that focus on analyzing the relation between behavior and its multiple interacting influences seem consistent and could be exercised within behavior analysis without abandoning functional analysis. By identifying these variables in our descriptive analyses or including them in our functional analysis (by controlling reinforcing contingencies and manipulating context), or by conducting frequency analyses, sequential analyses, or contingency analyses, we may be able to better understand behavior change and to explain behavior variability. Furthermore, we may work more successfully with existing data and generate more information about human behavior and its multiple influences than has been achieved thus far.

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BEHAVIOR ANALYSIS AT FLORIDA INTERNATIONAL UNIVERSITY

Formal training in basic and applied behavior analysis is one of the goals of Department of Psychology and the Department of Educational Psychology & Special Education 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 laboratory for experimental analysis of human and animal behavior, a daycare center, a child phobia center, a learning center, a state hospital and various community facilities. Recent research includes studies on stimulus equivalence and transfer of function, exploring infant learning using conditional discrimination and matching procedures, treatment of school phobias, exploring the conditioned basis of fear of the dark and fear of strangers in small children, "jealousy" between siblings, the effects of touch in mother-infant interactions, and imitation vs. direct contingency learning.

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 of the Psychology Department include Scott Fraser, Jacob Gewirtz, Michael Markham and Wendy Silverman, as well as adjunct faculty Beth Sulzer-Azaroff, Steve Starin, and Haydee Toro. For more information on graduate programs contact Jacob Gewirtz, Department of Psychology, Florida International University, Miami, Fl 33199, phone (305) 348-3375. The behavioral faculty of the Department of Educational Psychology and Special Education are Patricia Barbetta, Michael Brady, Martha Pelaez and Smita Shukla. For information on graduate programs in Educational Psychology & Special Education contact Michael Brady (305) 348-2552 or Martha Pelaez (305) 348-2090.