

Skills Learning in Behavioral Epigenesis

Gary Novak
California State University, Stanislaus

Skills learning is a cornerstone of behavioral epigenesis from a behavioral systems perspective. The characteristics of skills and their development are described. Examples of the skills learning paradigm are applied to motor, cognitive, language, and social development. Differences between traditional developmental, behavior analytic, and behavioral systems approaches are described.

Skills learning is a cornerstone of Behavioral Systems Theory (Novak, 1996, 1998). It is the fundamental process by which organized systems of behaviors emerge over time through environmental interaction. This paper describes the characteristics of skills learning as a natural developmental process and describes its relevance to specific developmental domains such as motor, cognitive, language, and social development.

A problem for behavior analysts investigating the development of behavior is that the experimental analysis of behavior focuses on short-run changes in behavior, whereas developmental questions tend to be long-run issues. Furthermore, viewed from outside the field of behavior analysis, the small set of simple, but parsimonious principles valued by behavior analysts, is viewed by traditional developmentalists as being too simple, and thus simplistic. I think skills learning is one way for behavioral developmentalists to address both these issues.

Behavior analysts have long accepted the importance of skills learning in the development of behaviors in applied settings. A recent electronic search of the abstracts of the *Journal of Applied Behavior Analysis* turned up 207 articles involving skills. These articles use learning principles to create skills in a wide-range of applied areas. However, as a natural developmental process, skills learning is virtually unexplored by behavior analysts.

Only recently have behavior analysts recognized the relevance of skills learning to developmental epigenesis (Novak, 1996). For example, Moerk (1993) has laid out an empirically based argument for the development of language as skills learning. Likewise, Novak (1996) has suggested Kurt Fischer's (1980) skills theory of cognitive development as an appropriate model for a behavior

analysis of cognitive development.

Characteristics of Skills

Zimmerman and Whitehurst (1979) identified seven issues which differentiate structural from functional viewpoints on development. One of these is the significance of skills. According to the authors, structural viewpoints, such as Piaget's theory of cognitive development, emphasize qualitative stages while functional views, such as behavior analysis, see development as in the "accretion of skills" (Zimmerman & Whitehurst, 1979, p. 16). From this perspective, new skills develop from previous ones. The authors cite Gagne as one example of a hierarchical approach to skill development. In such an approach, complex skills are the result of more basic ones. Commons and Rodriguez (1993) provide another hierarchical model from within the behavior analytic framework.

Behavior analysts have long recognized the nonlinearity of behavioral change. While an accretion of skills suggests linearity, this need not be the case. While shaping is defined as the process of reinforcing successive approximations, there is no requirement that the approximations be linear. For example, the steps in shaping an autistic child to emit the word "ball" are not equally spaced. The initial steps may be very small while at the end, there may be a large leaps. Another example is stimulus equivalence which is defined by the sudden emergence of untrained responses to derived relations among stimuli. This type of sudden change parallels the dynamic systems concept called a phase shift. Andronis (1983) and Johnson and Layng (1994, 1996) have described the sudden emergence of qualitatively different skills from those directly trained as "contingency adduction." The term suggests the nonlinear emergence of new skills by the application of contingencies.

Zimmerman and Whitehurst (1979) acknowledge this nonlinearity in skill development which they refer to as "discontinuities" (Zimmerman & Whitehurst, 1979, p. 17). The term "discontinuity" has been often used by traditional developmentalists to describe the stages which they feel characterize development. In the view of Zimmerman and Whitehurst these discontinuities or nonlinearities are seen by functionalists, including behavior analysts, as the result of inability to detect intermediate skills (what Thelen and Ulrich, 1991 call "hidden skills") rather than structurally based stages. Furthermore, Zimmerman and Whitehurst (1979) suggest that such nonlinearities

may result from the strong contingencies produced by a newly emergent cognitive skill. Thus, a new skill may be so much more functional that it is very quickly strengthened, while less functional forms are not.

This view is incorporated in contemporary dynamical systems approaches to development (e.g., Novak, 1996, Thelen & Ulrich, 1991). *Phase shifts* describe nonlinear changes from one dynamic attractor state to another. Attractor states or attractors are consistent patterns of responding. In behavior analysis, new functional response classes emerge from organism environment interactions. Initially these attractors are "soft assemblies" of behavior (Thelen & Ulrich, 1991). This suggests that in the early stages of the organization of behavior, there is a great deal of variability and susceptibility to perturbation.

Phase shifts occur through coalescent organization, which is the combination of necessary and sufficient conditions to produce organization or reorganization of behavior (Novak, 1996). Behavior analysts have frequently noted the increased variability and fragility of response classes in the initial phases of skills learning. Recently, Binder (1996), Lindsley (1996), and other behavior analysts have stressed fluency in the development of academic skills, as a way to reduce this fragility. Fluency leads to "hard" or at least harder assemblies and results from overlearning of skills (Dougherty & Johnston, 1996). Dynamical systems theorists find such fluency occurring naturally in developmental epigenesis as skills learning progresses.

As noted earlier, development as the acquisition of skills is a central part of Behavioral Systems Theory (Novak, 1998). There are five important characteristics of skills. First, skills are organized functional response classes. Second, skills develop over long periods of time during which enormous numbers of behavioral trials or learn units occur. Third, skills develop through environmental influences. Consequences, in the form of feedback or other types of reinforcement are among the most important environmental influences for assembling skills. Fourth, the unit of analysis is the four-term contingency. Finally, skills are hierarchical (Kaye, 1979). A corollary of this means that components of skills may be present but undetected prior to being assembled under coalescent organization. Thelen and Ulrich (1991) refer to these undetected components as "hidden skills".

Besides being compatible with behavioral systems theory, a skills learning approach is consis-

tent with observable conditions. Moerk's analysis of the intuitive use of the three-term contingency in mother-child language interactions (Moerk, 1990) is an example of this. In his analysis of mother-child linguistic interactions, Moerk found that mothers employ extraordinarily high frequencies of antecedents and consequences when shaping child verbal behavior.

In the remainder of this paper I shall illustrate how skills theory forms a central notion in theories explaining the development of various important behavioral domains.

Motor Development and Skills

Esther Thelen has placed a great deal of emphasis on skill development in her dynamic systems approach. A skills learning approach is a natural outcome of her early research which focused on motor behavior, particularly bipedal walking (Thelen & Ulrich, 1991). Since motor behaviors are easily observed, the characteristics of change which relate to skills learning is more easily apparent in this domain than others. Thelen and Ulrich (1991) experimentally manipulated environmental conditions in pre-walking infants to uncover the emergence of a hierarchy of walking skills and hidden skills.

Subsequently, Thelen and her associates have extended this skills development approach to other domains, such as cognition (e.g., Thelen & Smith, 1994).

Cognitive Development and Skills

Fischer (1980) considers the term "skill" to be equivalent to Piaget's "scheme" or to Skinner's "operant". He views skills as response sets, or response classes. In his view, skills are systematic variations in behaviors which are under the control of organismic and environmental conditions. Much of Fischer's theory is concerned with the hierarchical structure or organization of these response classes.

In Fischer's view, skills develop in a hierarchy of complexity. He postulated four tiers of development: reflex, sensori-motor, representational, and abstract (although he was reluctant to give reflex the full status of a tier). Each tier consists of qualitatively different organizations of cognitive skills. These tiers roughly translate to Piaget's stages of cognitive development, but Fischer's tiers are not equivalent to the Piagetian stages. The most obvious similarity is the sensori-motor tier where the

name is the same in both theories.

Within each of Fischer's tiers are four levels with the same basic structure. It is significant that the fourth level of a lower tier is the same as the first level of the next tier. Thus, the fourth level of the sensorimotor tier is the same skill as the first level of the representational tier.

The first level of each tier is a single operant response set or class. Metaphorically, this level is represented symbolically by a single dot. The second level is a relationship between two response classes which Fischer called a "mapping relationship" and is represented this by a line joining two dots representing two individual response classes. At level 3 are "systems", which are multidirectional relationships between more than two response classes. This is represented by a square comprised of mapped relationships. Finally, level 4 involves a relation which Fischer called "systems of systems" in which systems are related to other systems. This is symbolized by a cube. Recall that this level 4 relationship is the same as the first response class (level 1) of the next tier. Thus, a sensori-motor system of systems is also a simple representational response class.

Language Development and Skills

A third domain to illustrate a skills learning approach is the development of language. Ernst Moerk (1986) has long championed the view that skills learning is emerging as the appropriate paradigm for language acquisition. Like Fischer (1980), Moerk too views skills as behavioral structures which are hierarchically organized. As a skill, language develops gradually over many behavioral trials. Language is taught to the child by the parents, particularly the mother, through an intuitive teaching process employing the three-term contingency (Moerk, 1990).

Instead of the random linguistic environment suggested by psycholinguists, Moerk (1986) suggested that the environment parents provide is ideal for the teaching of language as a skill. Moerk identified four characteristics of this informal skills learning process. These are: 1) mothers repeat sentence types in highly intensive episodes; 2) children respond to the intensity of maternal prompting with large numbers of utterances; 3) mothers provide reinforcing and corrective feedback to the children; and 4) parents modify their language teaching based on the feedback from the child.

As an example of the intensity of the language

training, Moerk (1986) estimated that the child Eve in Roger Brown's *A First Language* (1973), would have heard as about 100,000 repetitions per month of each of the major sentence types. This evidence of enormous number of language skills teaching episodes is supported by Hart and Risley's work (1995) in which they estimate that children of professional parents may be exposed to 30 million words by the age of three.

In turn, children respond to their parents' language teaching with the development of language skills. For example, Moerk estimated from Brown's sample that Eve may have produced 500,000 linguistic responses per month. Similarly, the vocabulary development of children in three distinct socio-economic classes was directly related to the amount of language training, including word usage and feedback, by their parents (Hart & Risley, 1995). In sum, Moerk (1986, 1993) and Hart and Risley (1995) make a strong case that language acquisition is a skills learning process.

Antisocial Development and Skills

Finally, a skills learning process may be applied to the development of social development and personality. One example is Patterson's examination of the developmental of antisocial personality (Patterson, Reid, & Dishion, 1992). Gerald Patterson and his associates have for years detailed the development of antisocial behavior in children. Recently they have extended their analysis to include a process from basic training of antisocial skills in the preschool-age child through the development of an antisocial personality in the adult. This process fits the criteria for skills learning model. First, the antisocial behaviors become organized and reorganized over the course of development to the point that in maturity they are considered career antisocial adults with a stable "antisocial trait" (Patterson, et al., 1992, p. 27). At this point the pattern of responding consists of a constellation of highly skillful coercive and antisocial behaviors exist. The consequence is that these individuals are likely to be unemployed, have failing marriages, and are higher risks for substance abuse and for being arrested.

Second, as with other skills, antisocial behavior develops incrementally over a long period of time. The process starts with the learning of coercive behaviors in early childhood and continues into adulthood (Patterson, DeBaryshe, and Ramsey, 1989). It includes a stage during later childhood and adolescence which Patterson and

his associates (Patterson, et al., 1992) deem "polishing antisocial skills" (p. 12).

Third, Patterson, et al. stress environmental determinants. Initially these are family based in early childhood, but progress through typically negative interactions involving schools and normal peers. Consistent with the fourth characteristic of skills, Patterson and associates emphasize the importance of contingencies, particularly negative reinforcement in shaping antisocial skills. Finally, antisocial skills are organized hierarchically, with more basic coercive skills in early childhood leading to more complex ones as development progresses.

In summary, skills learning provides an effective paradigm for understanding the incremental yet nonlinear long-run changes that characterize human development. Two final points seem justified. First, it is important to emphasize that the structures which are organized as skills are response-stimulus and response-response relationships, not formal mental structures. This is an important difference between the skills learning model taken in Behavioral Systems Theory and traditional stage theories.

Second, the skills learning model emphasizes the building of highly complex skills from its components. This is the opposite of the task analysis approach employed by behavior analysis in teaching skills. In the latter, skills are deconstructed from a formal or functional analysis of the end skill. Ironically, this latter approach is suggestive of many traditional developmental perspectives which take a "tasks of childhood" approach (e.g., Piaget, Erickson) to development. In these a developmental outcome is identified, but the environmental interactions are never analyzed. In a skills learning approach the necessary and sufficient behavior-environment interactions are identified and the developmental outcome emerges from these.

References

- Andronis, P. T. (1983). *Symbolic aggression by pigeons: Contingency coadduction*. Unpublished doctoral dissertation, The University of Chicago.
- Binder, C. (1996). Behavioral Fluency: Evolution of a new paradigm. *The Behavior Analyst*, 19, 163-197.
- Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.
- Dougherty, K. M., & Johnston, J. M. (1996). Overlearning, fluency, and automaticity. *The Behavior Analyst*, 19, 289-292.
- Fischer, K. W. (1980). A theory of cognitive development: The control and construction of hierarchies of skills. *Psychological Review*, 87, 477-531.
- Hart, B., & Risley, T. R. (1995). *Meaningful differences in the experience of young American children*. Baltimore: Brookes.
- Johnson, K. R., & Layng, T. V. J. (1994). *The Morningside model of generative instruction*. In R. Gardner, D. M. Sainato, J. O. Cooper, T. E. Heron, W. L. Heward, J. Eshleman, & T. A. Grossi (Eds.), *Behavior analysis in education: Focus on measurably superior instruction* (pp. 173-197). Belmont, CA: Brooks/Cole.
- Johnson, K. R., & Layng, T. V. (1996). On Terms: On terms and procedures: Fluency. *The Behavior Analyst*, 19, 281-288.
- Kaye, (1979). *The development of skills*. In G. J. Whitehurst & B. J. Zimmerman (Eds.), *The functions of language and cognition* (pp. 23-55). New York: Academic Press.
- Lindsley, O. R. (1996). Is fluency free-operant response-response chaining? *The Behavior Analyst*, 19, 211-224.
- Moerk, E. L. (1983). *The mother of Eve -- As a first language teacher*. Norwood, NJ: Ablex.
- Moerk, E. L. (1986). *Environmental factors in Early language acquisition*. In G. J. Whitehurst (Ed.), *Annals of Child Development* (Vol. 3, pp. 191-235). : JAI Press.
- Moerk, E. L. (1989). The LAD was a lady and the tasks were ill-defined. *Developmental Review*, 9, 21-57.
- Moerk, E. L. (1990). Three-term contingency patterns in mother-child verbal interactions during first-language acquisition. *Journal of the Experimental Analysis of Behavior*, 54, 293-305.
- Moerk, E. L. (1992). *First language: Taught and learned*. Baltimore, Md: Brookes.
- Novak, G. (1996). *Developmental Psychology: Dynamical systems and behavior analysis*. Reno: Context Press
- Novak G. (1998). Behavioral Systems Theory. In M. Peláez (Ed.), *Special Issue: Behavior Analysis of Development*, *Mexican Journal of Behavior Analysis*, 24, 181-196.
- Patterson, G. R., DeBaryshe, B. D., & Ramsey, E. (1989). A developmental perspective on antisocial behavior. *American Psychologist*, 44, 329-335.
- Patterson, G. R., Reid, J. B., & Dishion, T. J. (1992). *Antisocial boys*. Eugene, Or: Castalia.
- Thelen, E., & Ulrich, B. D. (1991). *Hidden Skills* (Serial No. 233 ed., Vol. 36). *Monographs of the Society for Research in Child Development: Society for Research in Child Development*.
- Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of language and cognition*. Cambridge, MA: Bradford book.
- Zimmerman, B. J., & Whitehurst, G. J. (1979). *Structure and function: A comparison of two views of the development of language and cognition*. In G. J. Whitehurst & B. J. Zimmerman (Eds.), *The functions of language and cognition* (pp. 1-22). New York: Academic Press.