JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1990, 54, 113–127 NUMBER 2 (SEPTEMBER)

THE HISTORY OF IMITATION IN LEARNING THEORY: THE LANGUAGE ACQUISITION PROCESS

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The concept of imitation has undergone different analyses in the hands of different learning theorists throughout the history of psychology. From Thorndike's connectionism to Pavlov's classical conditioning, Hull's monistic theory, Mowrer's two-factor theory, and Skinner's operant theory, there have been several divergent accounts of the conditions that produce imitation and the conditions under which imitation itself may facilitate language acquisition. In tracing the roots of the concept of imitation in the history of learning theory, the authors conclude that generalized imitation, as defined and analyzed by operant learning theorists, is a sufficiently robust formulation of learned imitation to facilitate a behavior-analytic account of first-language acquisition.

Key words: theories of imitation, behavioral history, language, generalized imitation, children

Imitation has been the subject of much systematic investigation in psychology and has been an important concept in the study of the linguistic development of infants and children (Poulson, Nunes, & Warren, 1989). Over the years, several divergent accounts of the conditions that produce imitation have been proposed, creating numerous arguments and controversies. There has been disagreement on the criteria defining imitation, on the processes underlying it, and on the conditions under which imitation facilitates language acquisition. Some traditional psycholinguists such as Bloom, Hood, and Lightbown (1974), Clark and Clark (1977), Chomsky (1986), and Dale (1976) have not accepted imitation as sufficient to account for language acquisition in children. Nevertheless, they may have overlooked the concept of generalized imitation as presented in the context of operant learning theory. Generalized imitation, as defined and investigated by Baer and Sherman (1964), Baer, Peterson, and Sherman (1967), and Baer and Deguchi (1985), describes in an orderly way the conditions under which first-language acquisition occurs. A complete description of generalized imitation is provided in the final section of this paper.

Throughout the history of psychology, learning theorists have regarded imitation as such an important construct that virtually all of them have addressed imitation one way or another. In general, the development of the theories of imitation has followed the development of theories of learning, so that the history of imitation reflects in part the history of learning theory. The purpose of this paper is to trace the roots of the concept of imitation in the history of learning theory and to present the logic of a behavior-analytic account of language acquisition using the concept of generalized imitation.

CONNECTIONISM

The starting point of learning theory in the United States is Edward Thorndike's "connectionism." This is the original stimulus–response–consequence psychology of learning that has influenced so many psychologists of this century and continues to influence much experimentation worldwide. According to Thorndike, most animal and human learning is due to response-contingent reward in specific stimulus situations. In this form of learning, sensory stimulus impressions are connected to responses by "satisfaction" and "discomfort" as consequences, as described in Thorndike's (1911) famous law of effect.

Support for the preparation of this article was made available by Grant HD 22070 from the National Institute of Child Health and Human Development and by Research Award 667441 from the Professional-Staff Congress/City University of New York, Queens College/CUNY. Appreciation is extended to Thom Verhave, Donald M. Baer, and Bruce L. Brown for their helpful comments during the preparation of this manuscript. Correspondence and requests for reprints should be sent to Claire L. Poulson, Department of Psychology, Queens College/CUNY, Flushing, New York 11367/0904.

Thorndike believed that the laws of instinct, exercise, and effect were sufficient to explain the phenomenon of imitation in human and nonhuman behavior. He considered some forms of imitation to be purely instinctive and others to be only adjuncts to the formation of a habit. Using these two concepts, he described the human imitative process as follows: A child produces a great variety of sounds instinctively. Some of these sounds resemble words and are rewarded by the child's environment. Thus, according to the law of effect, the child learns to use the rewarded sounds in similar situations to achieve similar results. Thorndike also considered the possibility that a child may instinctively feel satisfaction at producing a sound similar to the one that "rings in the ears of memory and has meaning" (Thorndike, 1911, p. 253). This type of satisfaction, Thorndike thought, is like the instinctive satisfaction experienced by someone who creates an object resembling some familiar and meaningful object in the person's world.

Even though Thorndike considered imitation to be of value in human learning, he assigned it less value in nonhuman learning. Although he recognized the fact that some birds imitate word-like sounds, he considered this phenomenon to be only a peculiarity of the species, an indirect result of an instinctive act having nothing to do with learning. Thorndike thought this phenomenon should be regarded as different from the phenomenon of imitation in humans.

Nevertheless, Thorndike recognized that some nonhumans act in many ways that appear to be truly imitative. For example, many young birds appear to lose the fear of telegraph wires or railroad trains soon after hatching and subsequently acquire habits of feeding on certain plants and in specific places, like their mothers. Most young nonhumans behave like their mothers, but Thorndike believed that this only represents a pseudoimitative phenomenon resulting from some instinct. Thorndike failed to demonstrate learning by imitation in nonhumans. His typical experiment with dogs, cats, and monkeys was to place 2 subjects in similar cages, one next to the other. One of the subjects was trained to get out of the cage, and the other was untrained. Although the untrained subject watched the trained subject's motions of getting out of the cage many times, the untrained subject failed to learn the trick. Thorndike reasoned that there is no proof that nonhumans imitate muscular acts of other nonhumans, and he believed that those acts that appear to be imitative only simulate imitation (Thorndike, 1911). Thorndike was fully aware of the fact that his views contradicted the testimony of several animal trainers who claimed that nonhumans do learn by imitation, but he insisted on his view because he could not explain this phenomenon. According to the law of effect, the only way to learn is by doing and then experiencing satisfaction. Because the phenomenon of secondary reinforcement (Skinner, 1938) or symbolic reward was not familiar to Thorndike, a complete explanation of imitation in terms of the law of effect was not possible.

Thorndike was not the only turn-of-the-century theorist who regarded imitation as an instinctive act. At that time, the concept of instinct was so popular that it was used to explain many phenomena that are now analyzed in terms of other learning processes. As a result, several psychologists of the late 19th and early 20th centuries thought imitation to be innate. Some of them, like Thorndike's predecessor C. L. Morgan (1896), described two forms of imitation in humans and nonhumans: "instinctive" and "intelligent," both based on innate tendencies. "Instinctive imitation . . . is an organic response independent of experience; intelligent imitation is due to conscious guidance, the result of experience, and based upon the innate satisfaction which accompanies the act of reproductive imitation" (Morgan, 1896, p. 174). John Watson (1919), who attempted unsuccessfully to study imitation in infants, recognized that the existing analysis of the imitative instinct was incomplete, but he considered Thorndike's view to be "as accurate as any we have" (Watson, 1919, p. 259). Robert Woodworth (1918) also agreed with Thorndike in that "imitation appears not to afford a means by which animals learn" (Woodworth, 1918, p. 184). Nevertheless, Woodworth recognized that in humans there is "a natural tendency to try to imitate" (Woodworth, 1918, p. 185), which is important in the early life of the individual and facilitates trial-and-error learning. Other theorists, like Tarde (1895/1903), Ross (1908), and Wissler (1923), emphasized the role of the imitative instinct in the social development of the individual. From the point of view of the

learning theorists, the main problem with this "nativistic" view of imitation is that, by considering imitation to be instinctive, these investigators retarded further scientific inquiry regarding the learning processes underlying the phenomenon.

CLASSICAL CONDITIONING

As Thorndike was formulating his law of effect, the reflex was increasingly subjected to experimental analysis (Sechenov, 1863/1965; Sherrington, 1906). In psychology, reflex was defined as "the reliable production of a particular response by a specified stimulus" (Catania, 1984, p. 32). Reflex relations came to be considered as the fundamental units of behavior and the basis for understanding complex behavioral processes (Skinner, 1938). All responses, simple or complex, were regarded as the combination of reflex relations; whenever the eliciting stimuli of responses were not obvious, appropriate stimuli were hypothesized. In addition, all behavior was regarded as a chain of reflexes, because it was assumed that the elicited response of one reflex could function as the eliciting stimulus of another.

Pavlov's (1927) experimental study of conditioned reflexes grew out of the above hypothesis concerning the centrality of the reflexes. In his classic experiment, food powder was placed in a dog's mouth (unconditioned stimulus) and salivation was produced (unconditioned reflex). When an arbitrary neutral stimulus was paired repeatedly with the food, it came to produce salivation in its own right (conditioned reflex). The neutral stimulus had become a conditioned stimulus. Although the three concepts of contiguity, reflex, and conditioning were well known to science before Pavlov's experiments, Pavlov conceptualized them differently—he was one of the first to study the phenomena of conditioned reflexes empirically and to provide the terminology for them.

George Humphrey was one of the first to explain imitation as conditioned reflexes. Noting that an imitative response resembles the stimulus that produces it (activity of another organism), Humphrey defined imitation as "action involving a conditioned reflex the secondary stimulus of which is similar to the reaction" (Humphrey, 1921, pp. 4–5). In this way, he used the notion of reflex chains to explain imitation before this notion became popularized by Holt. Humphrey described imitation as follows: In the case of a crying baby, the original stimulus may be pain. But once the baby starts crying, it produces a response that is also an auditory stimulus, that is,the crying as heard by the baby itself. This secondary auditory stimulus produces another response, the reaction, which is more crying, and through this "circular reaction" more crying results in further crying. "Action of this type may be regarded as the elementary unit of imitation. It depends upon the fact that man and animals have senses by which they can perceive the reactions to stimuli from the same or other senses" (Humphrey, 1921, p. 4).

Humphrey's analysis has two serious limitations: First, he does not explain how an activated reflex ever abates. He does mention that the reflex disappears when it stops being supported by the primary stimulus, but he does not explain how that happens. Second, he does not explain how infants come to imitate others. He gives only a partial answer to this question by observing that in cases of human and nonhuman imitation of others "the original secondary stimulus comes from without" (Humphrey, 1921, p. 5), meaning outside of the body.

Humphrey's problems were encountered by all the theorists who tried to explain the phenomenon of imitation using the Pavlovian conditioning model. Theorists who took such an associationist stand are many, but four of them are especially worth mentioning. Alexander Bain (1855) was one of the first theorists who rejected the notion, long before Thorndike's and Pavlov's time, that imitative behavior is instinctive. Bain also made some very important observations that are consistent with later interpretations of imitation as a learned response. Bain held that imitative behavior does not appear very early in life, that it develops slowly, and that young children imitate adults much less than adults imitate young children. Bain used a simple associationist view and tried to explain the phenomenon of imitation as a repetition of connections of stimuli and responses. These connections are based on some "coincidence between a movement and the appearance of that movement in another person" (Bain, 1855, p. 408). The main problem with Bain's position, which was also a problem for the Pavlovian explanation of the phenomenon,

was that it could not explain why some associations lead to imitation and some do not.

Like Humphrey, Floyd Allport (1924) also rejected the idea of an instinctive drive to imitate. He believed that "some acts of alleged instinctive imitation are to be explained as conditioned circular responses" (Allport, 1924, p. 240). When children hear themselves talk, they establish ear–vocal reflexes by associating the auditory and the speech centers, as in the following example:

> Chance articulation of the syllable *da* causes the baby to hear himself say it. The auditory impulse is conveyed to the brain centers where it discharges into the efferent neurons to muscle groups used in pronouncing the same syllable. An ear–vocal habit for *da* is thus established. (Allport, 1924, p. 184)

Thus, when children perceive speech, the effect of that speech is merely to invoke already established reflexes, such that the perceived speech is not imitated but only repeated. Allport thus used the idea of the circular associative mechanism with special emphasis on the role of social stimuli in eliciting imitation.

Another investigator who rejected the idea of a native imitative tendency and adopted an associationist position was John Dashiell (1928). Dashiell identified and described two types of imitation: habitual and intentional imitation. Habitual imitation is "some sort of learned reaction, learned by the process of attaching the response (not in itself a new one) to the sound or sight of another person so acting" (Dashiell, 1928, p. 434). This type of imitation was later termed by Miller and Dollard (1947) "matched-dependent behavior." Intentional imitation is "the intentional copying of word, deed, or feeling" (Dashiell, 1928, p. 434), a process that was later termed by Miller and Dollard (1947) "copying." Although Dashiell described these two types of imitation, he did not identify the specific conditions under which each one of them takes place.

Special attention should be given to Edwin Holt (1931), whose theory of imitation has influenced a great number of social psychologists. Holt differentiated between imitation (responding to another person's stimulus) and iteration (responding to one's own stimulation). He held a purely associationist position and used his "reflex-circle" theory to explain the two phenomena as follows: Nervous excitations from the central nervous system activate the motor neurons of the muscles responsible for producing a certain sound. The nervous excitations are random, and the sound that is made is a random response. This sound, by stimulating the child's auditory receptors, sends an excitation through the auditory nerves to the central nervous system. The incoming excitation becomes associated with the abovementioned random nervous excitation, because it arrives only a second or two after it in the central nervous system. Thus, through association by contiguity, the incoming excitation will restimulate exactly the same motor neurons of the muscles that produced the abovementioned sound, and the muscles will produce the same sound again. After this process is repeated a few times, the impulses elicited by this sound in the ears will form a synaptic connection with the nerves going to the muscles that produced the particular sound. Thus, a reflex circle will be formed, and the infant will repeatedly produce any sound that stimulates its hearing. When this process is well established, the infant will also repeat similar sounds produced by other persons. Although Holt's theory explained how a child comes to imitate others, the theory did not explain how iteration ever ceases. He admitted that a satisfactory answer to this question had not been found.

Miller and Dollard (1947) commented on two additional points in Holt's theory. One of them was that, according to the associationist view, a child should cry harder upon hearing itself cry. The child should also cry harder upon hearing other children cry. Repeated casual observations do not support these conclusions. Holt's theory also assumed that the mere temporal contiguity between an auditory stimulus and a vocal response is sufficient to strengthen a connection between them. But Miller and Dollard asserted that this assumption is not correct. They hold, as did Thorndike, and later, Skinner, that the strengthening of the connection depends also upon reward, and that without it, extinction will take place.

HULL'S MONISTIC THEORY

As experimentation in learning theory progressed, it became apparent that both Thorndike's and Pavlov's approaches were seriously limited in their account of many learning phe-

nomena. Pavlov's theory could not explain the fact that some conditioned reflexes were very different from the unconditioned reflexes with which they were paired. Thorndike's theory could not explain any kind of learning that occurred without the organism's performing the actual response and experiencing satisfaction. But in the 1930s and 1940s, psychologists came to believe that both theories might be correct, each explaining different learning processes and complementing each other, in the original two-factor theory of learning. According to this theory, the two different kinds of learning, conditioning and habit formation, taken together could account for all learned behavior (Mowrer, 1960a). Thus, by the mid-20th century, psychological thinking was moving toward an integration of the two approaches. One investigator who attempted this synthesis to create a monistic theory of learning was Clark Hull (1943).

Hull was interested in formulating a single theory of learning that could explain the behavior of organisms. His theory formally acknowledged the importance of historical variables, such as a training history in similar situations, and deprivational variables, such as biological need-states. Hull believed that the way these variables influence the organism's responding could be summarized by hypothetical constructs such as drives and habits, which could be inferred from the organism's history or behavior.

There were two main sources of influence that affected Hull's position. One of them was Pavlov's theory of conditioned reflexes, and the other was Thorndike's revision of the law of effect, supported by the phenomenon of the spread of effect, which came about as follows: After a series of experiments, Thorndike came to discard the idea that reward and punishment have equal and opposite effects, as he had thought originally. He concluded that punishment does not weaken stimulus–response (S–R) connections, but may, in fact, strengthen them. Nevertheless, he observed that reward strengthens S–R connections more so than punishment does. Furthermore, experimental evidence suggested that reward strengthens not only the connection that it temporally follows but also adjacent connections. Thorndike held that the effect of reward diminishes as the unrewarded connections are temporally removed from the rewarded connection. Even punished connections can be strengthened to the extent that they are temporally proximate to the rewarded connection.

Under the influence of the above theoretical formulations of Pavlov and Thorndike, Hull considered the possibility that all forms of learning may be due to a single source of reinforcement, namely drive reduction, and that both conditioning and trial-and-error learning may be explained by only one set of assumptions. His reasoning was as follows: When an organism emits a response to terminate a drive, such as the one provided by an electric shock, the animal receives reinforcement through drive reduction, and the connections between the drive stimulus and the response are strengthened. The same reinforcement can also strengthen the connections between the response and other stimuli, such as the sound of a buzzer, that might be present during the reduction of the drive. When these connections get strong enough to cause drive reduction to the sound of the buzzer alone and in advance of the shock, "conditioning" is said to have taken place (Hull, 1943).

Hull's attempted synthesis of conditioning and trial-and-error learning was applied by Miller and Dollard (1947) to the formulation of their well-known imitation theory. According to Miller and Dollard, four fundamental factors are involved in the learning process: drive, response, cue, and reward. Their relationship can be summarized as follows: An organism emits a response in the presence of cues in order to reduce a drive. If the response is not rewarded by a drive-reducing event, it drops out, and other responses appear. If the response is followed by a drive-reducing event, it is rewarded, and the connection between this response and cues that are present is strengthened. "This strengthening of the cue-response connection is the essence of learning" (Miller & Dollard, 1947, p. 17). Miller and Dollard used their drive-cue-response-reward paradigm to explain the phenomenon of imitation. They held that imitation could be subsumed under three different "submechanisms": *same* behavior, *matched-dependent* behavior, and *copying* (Miller & Dollard, 1947, p. 91).

The characteristic element of the same behavior is that "two people perform the same act in response to independent stimulation by the same cue, each having learned by himself to make the response" (Miller & Dollard, 1947,

p. 92). For example, two people may enter the same door because of the sign above it reading "enter." "*Same* behavior may be learned with or without imitative aids" (Miller & Dollard, 1947, p. 92).

The second submechanism of imitation, matched-dependent behavior, occurs whenever there is a leader who responds to the environmental cues for rewards and an imitator whose responses are evoked by cues from the leader's behavior. An example of matched-dependent behavior may illustrate how this submechanism of imitation works: Two children, Jim and Bobby, were playing at home in the evening. While playing, Jim, the older child, heard the sound of their father's footsteps on the stairs. Bobby, the younger child, did not attend to this important cue. Jim ran to the kitchen to be there when the father (who usually brought candy) came in through the back door. Bobby happened at that time to run behind Jim. When Bobby got to the kitchen, Jim got his candy and so did Bobby. As a result of being rewarded, Bobby ran more often at the sight of his brother running, and often he received candy. Eventually, Bobby ran when Jim ran, but Bobby never learned to respond to the cues to which Jim responded. Miller and Dollard hold that some conditions of social life provide rewards for the learning of matched-dependent behavior, and they conclude that

> In social life, individuals are constantly being placed in situations analogous to the one above. The young, the stupid, the subordinate, and the unskilled must depend on the older, the brighter, the superordinate, and the skilled to read cues which they cannot themselves discriminate. They can respond only in the wake of those better instructed. Society, as will be shown, is so organized that the situation diagrammed above occurs over and over again. (p. 97)

According to Miller and Dollard, copying, the third submechanism of imitation, is a more complicated process than matched-dependent behavior. Copying occurs whenever there is a copier and a model, who also serves as a critic, punishing or rewarding the copier for unsuccessful or successful matching of a response. "It is crucial that the copier know when his behavior is the same; . . . in the end the copier must be able to respond independently to the cues of sameness and difference" (Miller & Dollard, 1947, p. 92). Miller and Dollard's analysis of the task of learning to sing illustrated the process of copying, with the teacher acting as a singing model and the copier attempting to match the notes. In their example, first the model produced a note, whose pitch provided a cue for the copier to join in with his or her own note, thus producing additional important cues for the copying process. The copier could not respond to the cues of sameness or difference in the pitch of these two notes; therefore, the copier in the course of learning proceeded to produce notes similar in pitch to those of the model in a trial-and-error fashion. Only the model, who also acted as a critic, could respond to the cues produced by the notes differentially, and said "yes" when the two notes were of the same pitch and "no" when there was a difference between them. The critic's "no" and the internal state of anxiety that it produced in the copier acted as a drive and as a cue to the copier to vary the response in a random manner, until the range of trial and error was limited to the correct note, to which the critic said "yes."

> As discrimination was improved, so that the copier was almost certain to react to the cues indicating difference with responses producing acquired drive, and to the cues indicating sameness with responses producing acquired reward, the copier became able to practice trial-and-error matching without aid from the critic. This may be expressed in abbreviated form by saying the copier could become his own critic. (Miller & Dollard, 1947, p. 157)

Miller and Dollard (1947) compare copying with matched-dependent behavior as follows:

> In both cases, the responses are connected to a cue from an independent subject or model. In both, likewise, the punishment of non-matched responses and the reward of matched responses eventually result in conformity of behavior between the leader and the follower. The essential difference between the two processes is that in matched-dependent behavior the imitator responds only to the cue from the leader, while in copying he responds also to cues of sameness and difference produced by stimulation from his own and the model's responses. (p. 159)

Although copying appears to be a more meaningful submechanism of imitation than matched-dependent behavior, copying is, nevertheless, dependent upon a critic, internal or otherwise, who says "yes" or "no." Subsequently, the copier is reinforced by the internal states that "yes" or "no" creates. This follows an instrumental paradigm with no appeal to secondary reinforcement.

Many investigators have criticized the Miller–Dollard (1947) analysis of imitation. They claim that Miller and Dollard did not study imitation, but only discrimination, during which the so-called imitator responded to cues from the behavior of others (Mowrer, 1960b). Furthermore, the Miller–Dollard analysis of imitation may have accounted for acquisition of some isolated vocabulary in children, but it did not explain adequately the full process of language acquisition from babbling to use of complete sentences.

It is interesting to note that Miller and Dollard (1947) discuss the concept of secondary reinforcement, introduced by Skinner (1938) and others (see Keller & Schoenfeld, 1950). In fact, Miller and Dollard considered the possibility that the voices of an infant's caregivers may acquire reward value that in turn helps reinforce infant babbling. Nevertheless, Miller and Dollard only mentioned this possibility but did not elaborate on it, choosing rather to concentrate on the drive-cue-response-reward paradigm in which the Thorndikian notion of trial-and-error learning was incorporated, and to make that the focal paradigm to describe imitation in the social learning of the individual. It was O. Hobart Mowrer (1960a, 1960b) who incorporated the phenomenon of secondary reinforcement in his autistic theory of imitation and offered a more satisfactory account of nonhuman and human word learning.

TWO-FACTOR THEORY

As experimentation in learning theory continued, several problems were identified in Hull's monistic theory of learning (Mowrer, 1960a), one of them being the fact that Hull's theory synthesized the Pavlovian and Thorndikian forms of learning only when the response to the conditioned stimulus was the same as the response to the unconditioned stimulus. But often it was shown that the two responses may be radically different, for example, an organism's unconditioned response may be running, but its conditioned response may be jumping. Furthermore, it was becoming apparent that although the original two-factor theory had an advantage over the Pavlovian and Thorndikian views considered separately, it could not account for some important learning phenomena, one of those being the phenomenon of avoidance learning (Mowrer, 1960a).

To offer an alternative explanation of avoidance learning, Mowrer formulated the second version of two-factor theory by taking into account the phenomenon of fear conditioning. Consider a typical experiment in which a rat is placed in a long narrow box consisting of two compartments, one of them black and the other white. Suppose that the rat receives shock only in the white compartment, and always after the sound of a buzzer. After exploring the box, if the rat stays in the white compartment and receives a shock, it will escape by running into the black compartment. If we remove the rat from the black compartment and place it back in the white compartment and produce the sound of the buzzer, the rat will not wait for the shock. It will avoid the shock by running into the black compartment immediately. This behavior has been called avoidance learning. According to Mowrer (1960a), in the avoidance learning experiment the rat learns (a) to be afraid of the sound of the buzzer in the white compartment and (b) to reduce the fear, and avoid the shock when it is presented, by running into the black compartment. First, fear operates as an intervening variable and gets attached to neutral stimuli through conditioning, inducing a secondary drive. Then, fear motivates the subject to perform an instrumental act to reduce the drive. Mowrer termed the former type of learning *sign learning,* and the latter, *solution learning.* He believed that sign learning involved the smooth muscles and produced involuntary responses (emotions), whereas solution learning involved the skeletal muscles and produced voluntary responses (behavior).

Later, Mowrer's second version of the two-factor theory of learning was revised by Mowrer himself to offer a satisfactory account of the phenomenon of secondary reinforcement, and at the same time to "provide the basis for a new and superior theory of habit" (Mowrer, 1960b, p. 7). Mowrer, in his revised version

of two-factor theory, considered a fact that was already known to learning theory, namely that a first-order conditioned stimulus can act as a secondary reinforcer, not only to produce higher order conditioning but also to produce new habits. For example, if an organism is taught to salivate upon the occurrence of a salient stimulus, the subject, if given the opportunity, will emit a response that will produce the salient stimulus. In other words, the subject will learn to perform a response, not to receive reward but to receive the sign or the promise of the reward. The term *drive* has been used to describe this tendency to emit a certain response in the presence of a certain need. According to Mowrer, behavior consists of two kinds of approach and two kinds of avoidance tendencies:

> If an *independent stimulus* arouses fear, flight is likely to follow; whereas *response-correlated stimuli* which arouse fear produce inhibition. And if an independent stimulus arouses hope, approach will occur; whereas response-correlated stimuli which arouse hope produce response facilitation or "habit." (Mowrer, 1960b, p. 10)

Thus, the new version of Mowrer's revised two-factor theory considers all learning to be sign learning, with solution learning as its derivative, and the theory assumes two kinds of reinforcement: drive decrement (reward) and drive increment (punishment).

Mowrer applied this new version of two-factor theory to first-language learning and offered a new theory of language acquisition, which came to be known as the "autism" or the "autistic" theory of imitation (Mowrer, 1960b). According to this theory, for an organism to learn to produce a particular sound, the sound has to be heard repeatedly, in association with a form of decremental reinforcement. For example, in the case of the human infant, the caregiver's voice is likely to be paired with food, warmth, and comfort. In this way, the sound takes on secondary reinforcement properties, so that when the infant hears itself make the sound (or an approximation of it) the infant will be automatically reinforced, and the probability increases that the infant will repeat the sound. "Imitation, as thus interpreted, becomes a sort of automatic trial-and-error process, one that is dependent upon reward from another organism, or 'parent person,' only in an indirect, derived sense" (Mowrer, 1960b, p. 73). Thus, the main difference between Mowrer's autistic theory and Thorndike's trial-and-error theory of imitation is that, according to Mowrer, the organism acquires the habit of producing a sound not by making it and then experiencing satisfaction, but by experiencing satisfaction while hearing it being made.

Mowrer's own major criticism of the autistic theory of language learning has been its inability to account for children's use of negative words that have not been paired with the "good" things in life. To explain the phenomenon, Mowrer recognized the fact that children use positive and negative words in an instrumental fashion to receive reinforcement that is no longer autistic in nature. Thus, Mowrer recognized the significance of the instrumental use of language, but only after the language has been well established on an autistic basis (Mowrer, 1960b).

OPERANT CONDITIONING

A radical departure from the traditional S–R psychology began in the 1930s with the experimental work of B. F. Skinner, who rejected the use of hypothetical constructs and pursued a behavioristic philosophy of science. Skinner (1938) differed in his approach from the existing S–R psychology, which assumed that the reflex was the appropriate model for all behavior. Instead, Skinner distinguished between two kinds of responses, respondents, which are elicited, and operants, which are emitted. Although respondents are triggered by known eliciting stimuli, operants are not associated with any such eliciting stimuli. An operant may be associated with an antecedent stimulus situation only in the sense that the stimulus may set the occasion for the operant response to occur. In such a case, the operant response is called a discriminated operant, and the stimulus is called a discriminative stimulus. A discriminative stimulus and a discriminated operant may occur together in time, but Skinner did not view them as forming an S–R connection. In fact, the power of the discriminative stimulus is derived entirely from its association with contingencies of reinforcement. Thus, Skinner called attention to the type of conditioning in which reinforcement is associated with the response, rather than with

any stimulus producing the response. He called this type of conditioning operant conditioning. Reinforcement as a process names a relation between response and environment.

> The relation is complex and must include at least three components. First, a response must have some consequence. Second, the response must increase in probability.... Third, the increase in probability must occur *because* the response has this consequence, and not for some other reason. (Catania, 1984, p. 64)

Skinner argued that we can understand complex behavior in terms of two kinds of learning: stimulus discrimination and response differentiation. Stimulus discrimination is the type of learning that allows the organism to respond differentially in the presence of one or more stimuli called discriminative stimuli. Response differentiation is the type of learning that changes the organism's way of responding according to changes in the criterion of reinforcement. Thus, differential reinforcement of certain forms of responding can "shape" the organism's behavior. Stimulus discrimination and response differentiation permit the formation of response chains in which the response of one segment becomes a discriminative stimulus for the response of the next segment. Thus, Skinner analyzed behavior in general, as well as verbal behavior (Skinner, 1957) in particular, in terms of operant conditioning principles.

In his analysis of verbal behavior, Skinner (1957) emphasized the function of verbal responding. According to this analysis, verbal behavior is maintained by environmental contingencies, whose schedule remains relatively constant in a given cultural environment. According to Skinner, languages, as studied by linguists, are "the reinforcing practices of verbal communities" (Skinner, 1957, p. 461). According to Skinner, a functional analysis of verbal behavior can account for the origin of a verbal environment if a response "associated with a state of deprivation is an important stimulus for a 'listener' who is disposed to reinforce the 'speaker' with respect to that state of deprivation" (Skinner, 1957, p. 464). In this way Skinner was able to explain how a hungry human infant's reflexive crying can become an operant response shaped by the caregiver's presentation of appetitive stimuli and removal of noxious stimuli contingently upon the infant's vocal behavior. Skinner's analysis of language acquisition focuses primarily on the reinforcing practices of the larger cultural environment and the maintenance of speech in adults. Behavioral developmental psychologists focused the principles set forth by Skinner to address more directly the acquisition of adult-like sounds by human infants.

Specifically, Sidney W. Bijou and Donald M. Baer (1961, 1965, 1978) wrote the first developmental textbooks to use Skinner's behavior analysis approach to a learning theory of infant and child development. Bijou and Baer defined psychological development as "progressions in interactions between behavior and environmental events" (Bijou & Baer, 1961, p. 14). They defined verbal behavior as "that class of vocal behavior that is reinforced through the action of another person" (Bijou & Baer, 1965, p. 159), thus emphasizing the role of interactions of responses and stimuli in the infant's language acquisition process. Baer's student, Todd R. Risley (1966, 1977), following the behavioral developmental psychology tradition, combined operant conditioning elements with Mowrer's autistic theory of imitation and offered the most detailed operant model of first-language acquisition.

To reiterate, according to Mowrer's autistic theory of imitation, parental verbal stimuli become conditioned reinforcers by being associated with the "good things" in the infant's life. In turn, some of the infant's vocalizations, those approximating the parental sounds, are differentially reinforced by the stimuli they produce. The more similar the infant's sounds become to the parental sounds, the more reinforcing they become. Risley (1966, 1977), analyzing Mowrer's theory from an operant conditioning point of view, identified the following three problems.

First, Risley argued that mere pairing of a reinforcer with a stimulus is not sufficient to make the stimulus a conditioned reinforcer. He argued that a stimulus becomes a conditioned reinforcer only when it becomes a discriminative stimulus for a response to be reinforced. Because, in the natural environment, parental reinforcement of infant vocalizations does not appear to be contingent upon specific vocal responding, parental vocal responding is not likely to become discriminative for infant responding. Thus, parental vocalizations are un-

likely to become strong conditioned reinforcers. In fact, Risley need not have put forth this argument at all, because subsequent review of the conditioned-reinforcement literature indicates that it is not, indeed, necessary to demonstrate discriminative control by stimuli to label them conditioned reinforcers (e.g., Fantino, 1977). Nevertheless, it is the case that conditioned reinforcers are potentially weaker than primary reinforcers to the extent that their strength depends on their being paired with primary reinforcers. Thus, Risley's point that parental vocalizations may be relatively weak reinforcers is undisputed.

Second, Risley argued, even in the case in which parental vocal sounds acquire secondary reinforcement properties, the infant should produce these sounds with greater probability when the infant is in a state of deprivation. Nevertheless, observation shows that infants babble more when they are fed, dry, and content rather than deprived (e.g., Lewis, 1959).

A third problem with Mowrer's autistic theory of imitation, according to Risley, is that spectrographs indicate that parental sounds are different from infant sounds (e.g., Lenneberg, 1964). This difference would be expected to weaken the reinforcing properties of parental sounds considerably.

Thus, Risley's arguments suggest that infant vocalizations that approximate parental vocalizations may have only weak conditioned-reinforcement properties. More powerful reinforcement contingencies may be required to support an operant conditioning account of initial-language acquisition. What is needed for this account, according to Risley, is that some ongoing level of reinforcement from the infant's caregivers be made contingent on some level of infant vocalization. Only when the infant's operant level of vocalizations is sufficiently high will the weak conditioned reinforcers resulting from the infant's "autistic imitation" be able to increase the probability of adult-like sounds in the infant. In this analysis, Risley sees the parent as playing a more active role in the infant's language acquisition process than Mowrer did. According to Mowrer, all the parents have to do to produce language is talk while caring for their infants. According to Risley, in addition to talking while caring for their infants, parents must also provide direct contingencies for their infant's vocal behavior.

As a detail of Risley's first argument above, Risley states that parental reinforcement of infant vocalizations does not appear to be contingent upon specific vocalizations in the natural environment. Whereas his statement was true at the time, it should be noted that subsequent research and reanalysis of data (e.g., Moerk, 1983) suggest that parents may, indeed, present antecedents and consequences differentially with respect to the form and content of infant utterances. This new information does not weaken the force of Risley's main arguments, however, and, in fact, strengthens his overall position on the acquisition of language. Risley contributed two main points with his arguments: (a) that under certain conditions a weak conditioned reinforcer (similarity between parent and infant vocalizations) could have an important function in first-language acquisition, and (b) that those certain conditions (some level of direct parental reinforcement for infant vocalization) were likely to obtain in the natural environment. The new research merely buttresses Risley's latter point.

Another theorist, Fry (1966), emphasized the active role of the parent in the process of imitation even more than did Risley. Fry's description of the development of the phonological system is remarkably consistent with that of the operant model, with respect to the role of imitation in the process of first-language acquisition. According to Fry, during the babbling stage the infant learns to associate different kinds of speech sounds with the action of the articulatory organs that produce those sounds, and the infant practices the reproduction of the same sounds by repeating the same movements over and over. After the establishment of this feedback mechanism, the infant gains control over his speech activity and learns new sounds and modifies old sounds through imitation. Imitation "is here taken to mean simply that the child tries to produce a sound that strikes him as similar to the sound that he hears coming in from outside" (Fry, 1966, pp. 190–191). Although Fry is not a learning theorist, he holds that imitation plays a large role in the development of speech articulation. According to Fry, the acquisition of speech through imitation depends upon the parents' frequent presentation of vocal models and reinforcement. Parents present vocal models to their infants in appropriate contexts, and the infant's attempt to approximate the model is

usually followed by praise and repetition of the correct vocal model by the parent. Under these circumstances the infant should produce successively closer approximations to the model, eventually imitating the parent successfully. Gradually, the context will replace the adult model as the discriminative stimulus for the appropriate vocalizations. Thus, in his analysis Fry emphasizes the function of what Risley (1966, 1977) labels "discriminated imitation," during which the imitator is reinforced by an external agent for imitative responding only in the presence of a narrow range of discriminative stimuli.

Fry's discriminated imitation approach may be contrasted to Baer's generalized imitation approach, which focuses on the formation of a response class of imitation maintained by a conditioned reinforcer, the conditioned reinforcer being the class of stimulus similarities between the model's response-produced stimuli and the imitator's response (Baer & Deguchi, 1985; Baer et al., 1967; Baer & Sherman, 1964).

Baer and Sherman (1964) were among the first investigators to propose that similarity between the model's behavior and the observer's behavior may be the functional variable in producing the observer's imitative responding. In their experiment, Baer and Sherman used social reinforcement from a talking puppet to establish imitative mouthing, head nodding, and nonsense verbalizations in normal young children. As imitative responding of these three responses increased in strength, imitative responding of a fourth response (bar pressing) also increased in strength, even though that fourth response was never reinforced. When extinction of the three previously reinforced imitative responses was effected with 2 children, the bar-pressing response was also extinguished. When nonmodeling conditions were implemented with 2 other children, the bar-pressing response was extinguished along with the other responses. When contingent reinforcement of the three imitative responses was reintroduced, the bar-pressing response increased along with the other three responses in all 4 children. These findings suggested that similarity between the model's behavior and the observer's responding may have become a reinforcing stimulus dimension of the imitator's behavior.

Baer et al. (1967) demonstrated generalized imitation in another experiment in which they taught 3 nonimitative, developmentally delayed young children a series of discriminations. In the course of training, the experimenter presented a series of discriminative stimuli and reinforced the subject's correct imitative responding. Certain probe imitations were never reinforced. Nevertheless, never-reinforced imitative responding increased in strength and remained high as long as reinforcement of other imitative responding continued. When contingent reinforcement was discontinued for imitative responding during a differential reinforcement of other-than-imitating (DRO) phase of the experiment, both reinforced and nonreinforced imitation decreased in strength. When contingent reinforcement was reinstated for imitative responding, both reinforced and nonreinforced imitation increased in strength. Based on their research, Baer et al. defined generalized imitation as follows:

> Any behavior may be considered imitative if it temporally follows behavior demonstrated by someone else, called a model, and if its topography is functionally controlled by the topography of the model's behavior. . . . Such control could result, for example, if topographical similarity to a model's behavior were a reinforcing stimulus dimension for the imitator. (Baer et al., 1967, p. 405)

In their analysis of the research on generalized imitation, Baer and Deguchi (1985) described generalized imitation as a functional response class because of three empirical findings. First, some imitative responses that are never reinforced increase in probability as long as some other imitative responses are reinforced, and they decrease in probability when those other imitations are no longer reinforced. Second, the nonreinforced generalized imitative responses persist despite the differential schedule of reinforcement. Third, the quality of the nonreinforced generalized imitations covaries with the quality of the reinforced imitations. This last point is illustrated in the work done by Lovaas, Berberich, Perloff, and Schaeffer (1966) and Brigham and Sherman (1968). In the Lovaas et al. study, two schizophrenic children were reinforced for accurately imitating English words. As accuracy of English-word imitation increased, accuracy of

never-reinforced Norwegian words increased as well. The Lovaas et al. study was replicated by Brigham and Sherman with normal preschool children, who were also reinforced for accurately imitating English words. As accuracy of the English-word imitation increased, accuracy of never-reinforced Russian words increased as well. Nevertheless, Baer and Deguchi did not consider the description of imitation as a response class to be an explanation of the phenomenon.

> Here, response class is not an explanation; it is only the observation that reinforcement of some members of the class controls the other members in a similar way. Thus, simply describing imitation as a response class does not contribute to understanding such complex cases. It is how the response class is molded and maintained that should be explained. (Baer & Deguchi, 1985, p. 185)

Thus, Baer and Deguchi (1985) define imitation as generalized imitation and offer a conditioned-reinforcement explanation of the phenomenon, as follows: Once a response class of imitative responding is established through direct contingent reinforcement, similarity between the model's output and the observer's output becomes a conditioned reinforcer for any new imitative responding. Thus, new imitative responding is established and maintained as long as other members of the imitative response class are directly reinforced.

To provide further empirical evidence for the above explanation of the phenomenon of generalized imitation, Baer and Deguchi (1985) conducted a series of experiments in which children's preference for similarity was measured in a multiresponse apparatus. The apparatus was a five-paneled table top. Each panel contained a light and a push button. In some trials the middle panel was lit, and in other trials all four side panels were lit. When the middle panel was lit, the child had an opportunity to receive a reinforcer during baseline by simply pressing the button and during intervention by pressing the button and imitating the experimenter. When the side panels were lit, the child could choose among four different activities by pressing one of the four buttons and then engaging in its corresponding activity. The four possible activities were:

1. Observing the experimenter engaged in an activity.
2. Observing the experimenter engaged in an activity, and then imitating the experimenter.
3. Engaging in an activity different from the experimenter's.
4. Waiting for the next trial to start.

During baseline, the child's preference for the four activities was measured prior to the introduction of reinforcement contingent upon imitative responding. During training, the child's preference for the four activities was measured after being directly reinforced upon imitating the experimenter. It was found that the relative frequency of button pressing providing access to nonreinforced imitations increased during treatment and remained high as long as other imitative responding was directly reinforced. When reinforcement for this other imitative responding was discontinued, the relative frequency of button pressing providing access to nonreinforced imitation decreased to baseline levels. The preference to perform nonreinforced imitation increased again when contingent direct reinforcement for other imitative responding was reintroduced. Additional tests indicated that all subjects could clearly discriminate between responses that were to be reinforced and responses that were not to be reinforced. The authors concluded that "such clear discrimination weakens any explanation relying on difficulty of discriminating between the two classes of imitation" (Baer & Deguchi, 1985, p. 207). Thus, similarity is isolated as a variable controlling the production of generalized imitation.

Additional empirical evidence for the phenomenon of generalized imitation was provided by Poulson and Kymissis (1988), who demonstrated generalized gestural imitation in infants as young as 10 months of age. Furthermore, Poulson, Kymissis, Reeve, Andreatos, and Richards (in press) demonstrated generalized vocal imitation in infants as young as 9 months of age. By replacing the experimenter with a parent, the infants' full cooperation was ensured and their natural language learning environment was approximated. The findings of these two studies strengthen the operant-learning account of language development, because they demonstrated the phenomenon of generalized imitation in children at an age close to the age of 12 months, when most children emit their first words.

Most traditional psycholinguists (Bloom,

Hood, & Lightbown, 1974; Clark & Clark, 1977; Dale, 1976) downplay the role of reinforcement and imitation in language acquisition because observations in the natural environment suggest that children often produce novel linguistic forms such as "throwed." Precisely because such a word is novel it cannot have been modeled for the children to imitate, and because it has never been produced by the child before, it has never been reinforced. Traditional psycholinguists, therefore, interpret these novel forms as evidence of internal linguistic processes, and they thus dismiss the operant analysis of the language acquisition process. Nevertheless, the inadequacy of imitation to account for first-language acquisition may be due to an inadequate definition of imitation rather than to an inability of learning theory to account for the linguistic phenomena. Baer and Deguchi's (1985) definition of imitation as generalized imitation may be sufficient to account for the fact that imitation often occurs in the absence of direct reinforcement or other demand factors in the natural environment (Baer & Deguchi, 1985). Also, it is consistent with the observation that children produce many nonreinforced, novel imitative responses, as long as they are directly reinforced for similar imitative responding. Thus, the child who uttered the novel "throwed" may have imitated "throw" and been reinforced for its use. The same child may have imitated the use of the "ed" suffix to form past tense, and that performance may have been directly reinforced. Thus, "throwed" would be expected to occur as a member of a response class containing (mostly regular) verbs and past-tense suffixes such as *d, ed,* and *t,* until the child later learns the exceptions to the rules for regular verbs (Baer, Guess, & Sherman, 1972).

Furthermore, the operant language acquisition paradigm is sufficient to account for the process of language acquisition as proposed by current linguistic analyses (Dale, 1976). According to these analyses, complex speech units are not necessarily formed from simpler linguistic units combined together. What seems to be happening in the language acquisition process is that children learn to produce in toto many large linguistic units "working on the pronunciation of sounds, on acquiring words, and on sentence construction simultaneously throughout development" (Dale, 1976, p. 195). According to the operant analysis of language acquisition, the large linguistic units learned by children may be analyzed as response classes themselves (Risley, 1977). Further experimental analysis of the ways in which these response classes are formed should be the focus of a concerted research effort.

Experimental analysis of the conditions governing the formation (and nonformation) of imitative and other linguistic response classes would provide a satisfactory account of language acquisition at the empirical and theoretical levels for most behavior analysts. It is interesting to note that such analyses would probably not satisfy the questions of a more traditional psycholinguist, such as Chomsky, who would be likely to seek a separate mechanism to further explain the formation of response classes—perhaps a "response-class acquisition device" of some sort. The metaphysical assumptions of these divergent paradigms are so different that the same questions are seldom asked, and even then, the same questions are seldom satisfied by the same levels of explanation. This circumstance has the unfortunate effect of limiting dialogue and interest in empirical findings couched in language that falls outside one's own paradigm. It is to be hoped, nevertheless, that efforts to communicate across paradigms will continue to inform both, and that the behavior analyst, although outnumbered by nonbehaviorists, will continue to produce orderly descriptions of the conditions governing the formation and nonformation of imitative and linguistic response classes.

Tracing the concept of imitation in the evolution of learning theory makes it clear that generalized imitation, as defined and analyzed by Baer and Deguchi (1985), may be a sufficiently robust formulation of learned imitation to facilitate a behavior-analytic account for first-language acquisition. First, the theorists who regarded imitation as an instinctive act retarded further investigation of imitation as a learned phenomenon. Second, those who regarded imitation as a conditioned reflex could not explain how this reflex ever abates, and why some associations lead to imitation and others don't. Third, Hull's (1943) drive-response-cue-reward paradigm, as applied to imitation by Miller and Dollard (1947), led to an analysis of matched-dependent behavior, which has been regarded by operant theorists as mere discrimination learning and which, therefore, could not account for the generative nature of first-language acquisition. Fourth,

Mowrer's (1960b) autistic theory of imitation makes use of the phenomenon of secondary reinforcement to account for the production of sounds in human infants. Nevertheless, Mowrer's theory was unable to account for the infant's production of negative words, and it was further found to be inadequate by Risley (1977), who suggested that parents have to play a more active role in the language acquisition process. Both Risley's (1966, 1977) and Fry's (1966) theories emphasized the importance of environmental contingencies in the process of imitation, but Baer defined and studied imitation as generalized imitation in a way that provided a more satisfactory account of first-language acquisition using the operant-learning paradigm (Baer & Deguchi, 1985; Baer et al., 1967; Baer & Sherman, 1964). Because generalized imitation can account for novel linguistic forms such as "comed" or "throwed" as members of a response class based on past imitation and reinforcement for use of similar but regular verbs, the concept of generalized imitation is powerful. To the extent that we can experimentally analyze successively larger proportions of children's utterances within an operant-learning paradigm, it becomes less pressing to worry about nonlearning language acquisition paradigms that in principle render their subject matter unavailable for experimentation.

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