Acquisition of Imitative Speech by Schizophrenic Children

Abstract. *Two mute schizophrenic children were taught imitative speech within an operant conditioning framework. The training procedure consisted of a series of increasingly fine verbal discriminations; the children were rewarded for closer and closer reproductions of the attending adults' speech. We found that reward delivered contingent upon imitation was necessary for development of imitation. Furthermore, the newly established imitation was shown to have acquired rewarding properties for the children.*

With the great majority of children, the problem of teaching speech never arises. Speech develops within each child's particular environment without parents and teachers having to know a great deal about how it occurs. Yet, in some children, because of deviations in organic structure or prior experience, speech fails to develop. Children with the diagnosis of childhood schizophrenia, especially autistic children, often show little in the way of speech development (*1*). The literature on childhood schizophrenia suggests two conclusions regarding speech in such children: first, that the usual treatment setting (psychotherapy) in which these children are placed might not be conducive to speech development (*2*); and second, that a child failing to develop speech by the age of 5 years remains withdrawn and does not improve clinically (*2*). That is, the presence or absence of speech is an important prognostic indicator. It is perhaps obvious that a child who can speak can engage in a much more therapeutic interchange with his environment than the child who has no speech.

The failure of some children to develop speech as a "natural" consequence of growing up poses the need for an increased knowledge of how language is acquired. A procedure for the development of speech in previously mute children would not only be of practical importance but might also illuminate the development of speech in normal children. Although several theoretical attempts have been made to account for language development, the empirical basis for these theoretical formulations is probably inadequate. In fact, there are no published, systematic studies on how to go about developing speech in a person who has never spoken. We now outline a procedure by which speech can be made to occur. Undoubtedly there are or will be other ways by which speech can be acquired. Furthermore, our procedure centers on the acquisition of only one aspect of speech, the acquisition of vocal responses. The development of speech also requires the acquisition of a context for the occurrence of such responses ("meaning").

Casual observation suggests that normal children acquire words by hearing speech; that is, children learn to speak by imitation. The mute schizophrenic children with whom we worked were not imitative. Thus the establishment of imitation in these children appeared to be the most beneficial and practical starting point for building speech. The first step in creating speech, then, was to establish conditions in which imitation of vocal sounds would be learned.

The method that we eventually found most feasible for establishing verbal imitation involved a discrimination training procedure. Early in training the child was rewarded only if he emitted a sound within a certain time after an adult had emitted a sound. Next he was rewarded only if the sound he emitted within the prescribed interval resembled the adult's sound. Toward the end of training, he was rewarded only if his vocalization very closely matched the adult's vocalization —that is, if it was, in effect, imitative. Thus verbal imitation was taught through the development of a series of increasingly fine discriminations.

The first two children exposed to this program are discussed here. Chuck and Billy were 6-year-old in-patients at the Neuropsychiatric Institute at UCLA. These children were selected for the program because they did not speak. At the onset of the program, vocal behavior in both children was restricted to occasional vowel productions with no discernible communicative intent. These vowel sounds occurred infrequently, except when the children were tantrumous, and did not resemble the pre-speech babbling of infants. In addition, the children evidenced no appropriate play (for example, they would spin toys or mouth them). They engaged in a considerable amount of self-stimulatory behavior such as rocking and twirling. They did not initiate social contacts and became tantrumous when such contact was initiated by others. They evidenced occasional self-destructive behavior (biting self, head-banging, and so forth). Symbolic rewards such as social approval were inoperative, so biological rewards such as food were substituted. In short, they were profoundly schizophrenic.

Training was conducted 6 days a week, 7 hours a day, with a 15-minute rest period accompanying each hour of training. During the training sessions the child and the adult sat facing each other, their heads about 30 cm apart. The adult physically prevented the child from leaving the training situation by holding the child's legs between his own legs. Rewards, in the form of single spoonsful of the child's meal, were delivered immediately after correct responses. Punishment (spanking, shouting by the adult) was delivered for inattentive, self-destructive, and tantrumous behavior which interfered with the training, and most of these behaviors were thereby suppressed within 1 week. Incorrect vocal behavior was never punished.

Four distinct steps were required to establish verbal imitation. In step 1, the child was rewarded for all vocalizations. We frequently would fondle the children and we avoided aversive stimulation. This was done in order to increase the frequency of vocal responses. During this stage in training the child was also rewarded for visually fixating on the adult's mouth. When the child reached an achievement level of about one verbal response every 5 seconds and was visually fixating on the adult's mouth more than 50 percent of the time, step 2 of training was introduced.

Step 2 marked our initial attempt to bring the child's verbal behavior under our verbal control in such a manner that our speech would ultimately stimulate speech in the child. Mastery of this second step involved acquisition of a temporal discrimination by the child. The adult emitted a vocal response—for example, "baby"—about once on the average of every 10th second. The child was rewarded only if he vocalized within 6 seconds after the adult's vocalization. However, any vocal response of the child would be rewarded in that time interval. Step 3 was introduced when the frequency of the child's vocal responses within the 6-second interval was three times what it had been initially.

Step 3 was structurally similar to the preceding step, but it included the additional requirement that the child actually match the adult's vocalization before receiving the reward. In this and in following steps the adult selected the verbalization to be placed in imitative training from a pool of possible verbalizations that had met one or more of the following criteria. First, we selected vocal behaviors that could be prompted, that is, vocal behaviors that could be elicited by a cue prior to any experimental training, such as by manually moving the child through the behavior.

An example of training with the use of a prompt is afforded in teaching the sound "b". The training would proceed in three stages: (i) the adult emitted "b" and simultaneously prompted the child to emit "b" by holding the child's lips closed with his fingers and quickly removing them when the child exhaled; (ii) the prompt would be gradually faded, by the adult's moving his fingers away from the child's mouth, to his cheek, and finally gently touching the child's jaw; (iii) the adult emitted the vocalization "b" only, withholding all prompts. The rate of fading was determined by the child; the sooner the child's verbal behavior came under control of the adult's without the use of the prompt, the better. The second criterion for selection of words or sounds in the early stages of training centered on their concomitant visual components (which we exaggerated when we pronounced them), such as those of the labial consonant "m" and of open-mouthed vowels like "a." We selected such sounds after having previously found that the children could discriminate words with visual components more easily that those with only auditory components (the guttural consonants, "k" and "g," proved extremely difficult and, like "l" and "s," were mastered later than other sounds). Third, we selected for training sounds which the child emitted most frequently in step 1.

Step 4 was a recycling of step 3, with the addition of a new sound. We selected a sound that was very different from those presented in step 3, so that the child could discriminate between the new and old sounds more easily. To make certain that the child was in fact imitating, we randomly interspersed the sounds of step 3 with the sound of step 4, in a randomized ratio of about 1 to 3. This random presentation "forced" (or enabled) the child to discriminate the particular sounds involved, in order to be rewarded. There was no requirement placed upon the child in step 3 to discriminate specific aspects such as vowels, consonants, and order of the adult's speech; a child might master step 3 without attending to the specific properties of the adult's speech. Each new introduction of sounds and words required increasingly fine discrimination by the child and hence provided evidence that the child was in fact matching the adult's speech. All steps beyond step 4 consisted of replications of step 3, but new sounds, words, and phrases were used. In each new step the previously mastered words and sounds were rehearsed on a randomized ratio of 1 to 3. The next step was introduced when the child had mastered the previous steps—that is, when he had made ten consecutive correct replications of the adult's utterances.

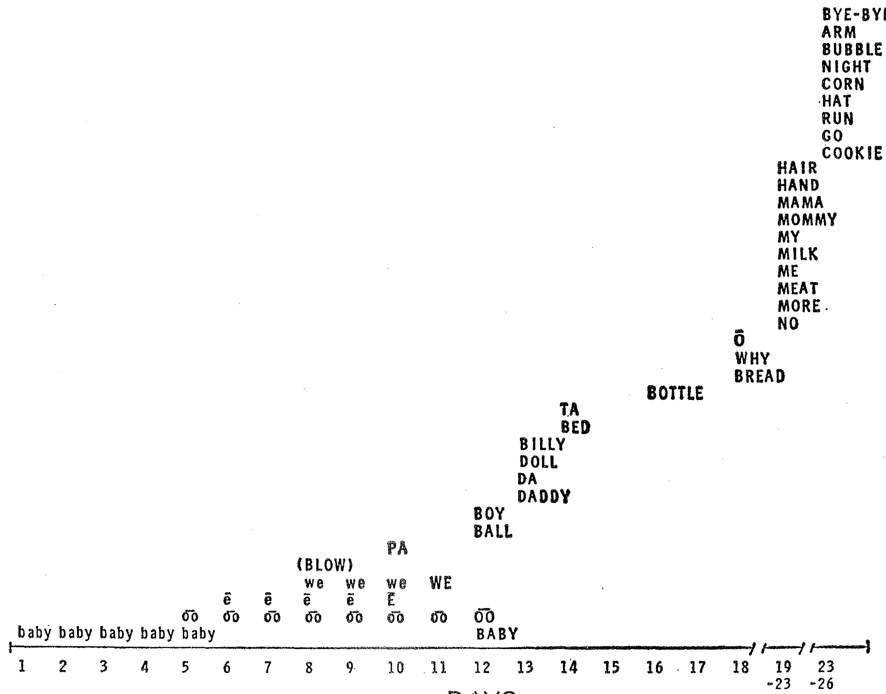

Fig. 1. Acquisition of verbal imitation by Billy. The abscissa denotes training days. Words and sounds are printed in lower case letters on the days they were introduced, and in capital letters on the days they were mastered.

One hour of each day's training was tape-recorded. Two independent observers scored the child's correct vocal responses from these sessions. A correct response was defined as a recognizable reproduction of the adult's utterance. The observers showed better than 90 percent agreement over sessions. When the child's correct responses are plotted against days of training, and the resulting function is positively accelerated, it can be said that the child has learned to imitate.

The results of the first 26 days of imitation training, starting from introduction of step 3, have been plotted for Billy (Fig. 1). The abscissa denotes training days. The words and sounds are printed in lower case letters on the days they were introduced and in capital letters on the days they were mastered. It can be seen that as training progressed the rate of mastery increased. Billy took several days to learn a single word during the first 2 weeks of the program, but a single day to master several words during the last 2 weeks. Chuck's performance was very similar to Billy's.

After 26 days of training both children had learned to imitate new words with such ease and rapidity that merely adding verbal responses to their imitative repertoire seemed pointless. Hence the children were then introduced to the second part of the language training program, wherein they were taught to use language appropriately.

The imitation training took place in

a rather complex environment, with many events happening concurrently. We hypothesized that it was the reward, given for imitative behavior, which was crucial to the learning. To test this hypothesis, the adult uttered the sounds as during the training and the children received the same number of rewards as before. However, the rewards were contingent upon time elapsed since the last reward, regardless of the child's behavior.

The data show a deterioration in imitation behavior whenever rewards are shifted from response-contingent to time-contingent delivery. It is concluded, therefore, that reward immediately following correct, imitative behavior (and withholding of reward following incorrect responding) is a crucial variable in maintaining imitative behavior in these children. The same finding has been reported by Baer and Sherman (*3*) who worked with imitative behavior in normal children.

Since the child was rewarded whenever he responded like the adult, *similarity* was consistently associated with food. Because of such association, similarity should become symbolic of reward. In other words, imitative behavior, being symbolic of reward, should eventually provide its own reward (Baer and Sherman, *3*). To test this hypothesis, both children were exposed to Norwegian words which they were unable to reproduce perfectly when first presented. The adult simply stated the Norwegian word and the child always attempted to repeat it; no extrinsic rewards were delivered. However, occasionally the child was presented with English words which the adult rewarded when correctly imitated. This procedure was necessary to maintain the hypothesized symbolic (learned) reward function of imitation.

The children improved in the imitation of the Norwegian words over time. It is as if they were rewarded for correct behavior. In view of the data pointing to the need for rewards in maintaining imitative behavior, and in the absence of extrinsic rewards, we would argue that the reward was intrinsic and a function of the prior imitation training. There is one implication of this finding which is of particular interest for therapeutic reasons: children may be able to acquire new behaviors on their own. (This finding contrasts with the frequent stereotype of a conditioning product, namely, that of an automaton unable to function independently.)

Currently, three new schizophrenic children are undergoing the same speech training program as Billy and Chuck. After 3 days of training, one of these children achieved a level of imitative behavior similar to that shown by Billy and Chuck after 26 days. It should be pointed out that schizophrenic children are a very heterogeneous group with respect to their speech histories and symptomatology in general, and that Billy and Chuck had failed in development to a profound degree. Insofar as one works with such a diverse population, it is likely that numerous procedures could be helpful in establishing speech.

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Unconditioned Response to Electric Shock: Mechanism in Planarians

Abstract. *Some implications of a mathematical theory relating neuronal geometry to the parameters of excitation in unconditioned response of planarians to electric shock are experimentally verified. The regions and patterns of primary neural excitation depend on the relation between the distribution of neural sizes and the waveform of the electric stimulus.*

Thompson and McConnell's classical conditioning paradigm for planarians (*1*) has been used, with several modifications, for a number of interesting and provocative experiments on the mechanisms of memory storage (*2*). In this paradigm the planarian is placed in a narrow plastic trough equipped with an electrode at each end and filled with water. Several seconds of brilliant illumination, constituting the conditioned stimulus, are followed by approximately a second of electric shock, the unconditioned stimulus, administered through the water by way of the end electrodes. Response of the planarian during the lighted period preceding the shock is scored as a conditioned response, and response during the period of shock is scored as an unconditioned response. Interpretation of the results of these experiments has been equivocal because of apparent discrepancies in the results of various laboratories (*3*, *4*) employing this paradigm. It must be emphasized that the discrepancies reported entail not merely a difference between the McConnell group and those critical of their results but also discrepancies among the results of the critics' experiments. Such fundamental variations suggest that one or more critical variables in the situation have not been adequately controlled; in some obvious instances, the experiments of the critics are among the most vulnerable.

The study of Barnes and Katzung (*4*) intimates that the kind of electric current pulse used for the unconditioned stimulus may be one such variable; they use a monopolar square-wave train instead of the inductorium output used by Thompson and McConnell and others (*1*, *2*). But while this study indicated relevancy of the electrical stimulus waveform it did not lead to reproducible results in other laboratories (*3*) or in our own.

For purposes of the present analysis the central nervous system of the planarian can be thought of as an ensemble of neurons and the neurons, in turn, as tubes with sealed ends and impermeable surfaces, containing an aqueous axoplasmic solution of ions. The use of electric shock as an unconditioned stimulus in the paradigm is equivalent to placing this ensemble of neurons in a spatially uniform, but temporally varying, electric field. The direct consequence of imposing an electric field on these neurons is to produce an ionic migration leading to a shift in the ionic distribution of the axoplasm from its resting state. If the perturbation induced in this ionic distribution by the electric field exceeds some threshold value in any surface region of the axoplasm of a neuron, then excitation occurs in that neuron.

If a field of intensity E is imposed on a solution of ions of charge q per mole and diffusion coefficient D, the flow, J, of these ions in a one-dimensional system will be

$$J = -D\, dC/dx + DqEC/RT \quad (1)$$