Developing a Verbal Repertoire Using Sign Language and Skinner's Analysis of Verbal Behavior

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Mark L. Sundberg
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DEVELOPING A VERBAL REPERTOIRE USING SIGN LANGUAGE AND SKINNER'S ANALYSIS OF VERBAL BEHAVIOR

Western Michigan University

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Ph.D. 1980
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Defective Language

A large number of persons within our culture suffer from weak verbal skills. For some, these deficiencies can go somewhat unnoticed as in the illiterate person who simply learns to avoid textual material or the stutterer who may avoid certain consonants or vowel-consonant combinations. There are more serious problems, however, for the individual who fails to acquire the basic verbal skills necessary for manipulating his environment. These persons are often labeled retarded, developmentally disabled, autistic, aphasic, or emotionally impaired.

It is often difficult to explain why certain individuals fail to acquire conventional verbal skills. Usually, the analyst does not have access to all of the critical variables. Some cases are clearer than others, such as those where there is some observable physiological defect (i.e., deafness, cerebral palsy, a traumatic injury to the parietal lobe of the brain, damage to the vocal musculature, or various operations). Certain diseases, such as meningitis or German measles, may produce permanent hearing losses which may also be responsible for an individual failing to acquire language. However, there is a large number of people who do not have any of these problems but still have weak or defective language skills. For these individuals, we must turn to the environment for an explanation. It has been known for
some time that if a normally hearing human is raised in an environment void of other humans language does not develop (Itard, 1932). Thus, some individuals may have been raised in an environment with very little contact with others. Also, if a normally hearing human is raised in an environment with another human but never hears vocalization, language will be defective. This usually occurs under situations where a developmentally disabled, non-vocal or deaf mother raises a child who never has contact with speaking people.

Still, however, the state institutions are filled with individuals who have no known physiological deficits and had speaking parents. One possible explanation for language failing to develop might be a simple lack of reinforcement in combination with direct punishment for vocalizing (e.g., "Be quiet," "Shut up, kid!" "Why do you make so much noise?"). A more complex analysis involves the role that automatic reinforcement and automatic punishment plays in language development. A child's babbling ultimately resembles the sounds that the parents make because these sounds are paired with the essentials of survival (e.g., food, shelter, milk), and the product of the child's vocalizations automatically strengthens their emission (Peterson & Michael, 1980; Skinner, 1957; Sundberg, 1980). If such pairing does not occur, language might not develop normally. Also, if a parent is extensively aversive and abuses the child, the vocalization may be paired with punishment; and a child would have little tendency to "play with sounds," disrupting the sequence of language acquisition. Mild to severe child abuse can be a major environmental cause of defective language behavior.
The By-products of a Defective Verbal Repertoire

Language is the most important aspect of human life. A child learns to talk, in part, because of various motivational conditions to which only he has access (e.g., food deprivation, aversive stimulation). Life becomes much easier for the child when he can successfully ask for water or coat or when he can tell his mother that he is sick. Appropriate language often results in a quick remediation of these problems. A child without language is usually at a loss, and many problems and discomforts are never understood. Therefore, it certainly is reasonable to expect various inappropriate behaviors to be learned in place of the more appropriate language behavior. Screaming, for example, can function as verbal behavior under certain circumstances. A mother in the supermarket is faced with an embarrassing situation when her three year old starts screaming after she says, "No candy." The mother may then give the child the candy to quiet him/her. This, of course, strengthens screaming as a way of asking for things. When language is defective, the individual may acquire several odd forms of verbal behavior, such as aggressive behavior, tantrums, or vocal nonsense. After several years (and reinforcements), these behaviors become a strong part of the individual's repertoire; and the behaviors are quite difficult to eliminate.

Self-stimulation and high rates of activity are also common by-products of defective language skills. Language, after all, allows a child to interact with others in the environment and usually brings a child a large amount of attention from parents. High rates of activity can also result in attention (e.g., chasing, grabbing) by parents or staff,
thereby having an effect on the environment which functions as rein-
forcement and maintains the behavior targeted for elimination. Such
ways of inducing adults and other children to behave can be a strong
form of reinforcement when other means are unavailable. A child learns
that his mother will look at him, scream, and get up and run across the
room if he climbs into the baby's crib. This may be followed by some
mild punishment, thereby decreasing climbing in the crib; but the rein-
forcement of the specific environmental change probably maintains large
classes of behavior; and other topographies will eventually occur. A
fish tank, for example, contains some of the defining features of a
crib (i.e., four legs, opening at the top) and that stimulus may con-
trol similar climbing behavior which, again, would result in the par-
ent's attention followed by mild punishment; and the cycle continues.
The parent may heavily reinforce appropriate behavior, but this is poor
competition for the reinforcement from specific environmental control.
As a result, parents may give up and institutionalize the child.

In summary, by-products of defective language skills often are the
main concern in schools and institutions. Often treatment is given to
eliminate a certain topography (e.g., head banging, aggressive behavior)
without consideration of its possible link to defective language. A
preventive approach to retardation and related impairments should begin
by an appropriate language training program.

Speech therapy is often ineffective with individuals who have a
long history of unsuccessful vocal communication, and attempts at devel-
oping a verbal repertoire are often abandoned. Recently, however,
there have been a number of research projects demonstrating that such
individuals can acquire sign language as an alternative to vocal behavior. Margaret Creedon has been credited with the first use of signs with hearing, non-vocal persons. She began her work in 1969 at the David School of the Michael Reese Medical Center in Chicago. Following her success with autistic children, several others began using sign language with various non-vocal populations (e.g., Bricker, 1972; Bonvillian & Nelson, 1976; Fulwiler & Fouts, 1976; Schaeffer, 1980; Topper, 1975); and recently reviews of this literature have been published (Fristoe & Lloyd, 1977; Poulton & Algozzine, 1980).

There are several reasons why non-vocal persons can acquire sign language more readily than vocal language. First, it is much easier to teach the person the form of the response. The learner's hands can be placed in the appropriate position, whereas the vocal musculature (which involves the diaphragm, the vocal cords, the false vocal cords, the epiglottis, the soft palate, the tongue, the cheek, the lips, and the jaw) can only be altered indirectly. That is, a therapist cannot control a learner's vocal muscles in order to produce certain words; but the hands can easily be molded into the correct positions. This makes the shaping process quicker, as well as allowing for more clear and unambiguous models of the appropriate response.

A second feature of a signing system is the greater potential for resemblance of the sign and the controlling variable. The sign for food, for example, is made by moving the closed finger tips to the mouth as in the process of eating. Because a large number of signs do resemble some aspects of the variable controlling the response, the controlling relationships are probably easier to develop.
A final, and more subtle, issue deals with the history of reinforcement and punishment related to vocal behavior that has prevailed for many of the people with ineffective vocal behavior. Such histories typically involve frequent failure to communicate vocally and considerable urging on the part of others to attempt communication. This is a situation which has a high probability of developing various negative emotional reactions and, similarly, a variety of inappropriate behaviors (Terrace, 1963; Ray, Sundberg, & Catherman, 1979). Effective instruction in signing may, to some extent, avoid involvement in this social and emotional repertoire.

Several researchers have developed "packaged" programs for teaching sign language to non-vocal persons (e.g., Creedon, 1975; Lake, 1976; Snell, 1974), and the current research began with an application of their suggested procedures. The subjects acquired many signs, but their repertoires were incomplete in several ways. Their language did not develop in a manner which could be considered analogous to that of a normal hearing child. There was very little "spontaneous" signing or conversational signing. Also, novel combinations of signs rarely occurred. Basically, the children could only give the name of objects, actions, or relations when asked to do so.

Part of the problem may be that most language training programs are derived from research and developments within the field of linguistics. A major problem with dependence on this field is that their domain is generally accepted as the study of the structure, or form, of a given language system. Elucidation of the process by which a person acquires and emits language is most often relegated to psychology. The
interface of the disciplines of psychology and linguistics has resulted in the field known as psycholinguistics, and it is probably here where the confusion asymptotes.

Within the field of psychology, there are three general orientations to language development. They are often identified as the biological, cognitive, and environmental approaches (Reber, 1973; Salzinger, 1978). Perhaps the main difference between these orientations relates to their attribution of causality with respect to language development. The biological position maintains that language is largely innate, and causality is assigned to innate language devices and other "pre-wired" neurological equipment. It is believed that once we thoroughly understand the human brain then we will thoroughly understand language development. This orientation is best exemplified by the work of Chomsky (1965) and Lenneberg (1972).

The cognitive approach to language maintains that language is controlled by internal processes which accept, classify, and store language information for future recall. Causality is assigned to these internal variables, and it is believed that once we can accurately conceptualize these hypothetical processes we will thoroughly understand language. This orientation is perhaps best exemplified by the work of Piaget (1926, 1951) and Brown (1973).

The third approach to language development is often called an environmental or behavioral analysis of language. This orientation maintains that language is behavior controlled by its relationship with antecedent and consequent events as well as those operations which make those consequences effective (motivation). Language, then, is attributed
to these environmental events. It is believed that once we thoroughly understand the environment then we will understand language development. This orientation is best exemplified by the work of Skinner (1957).

The language programs cited above were basically derived from the cognitive or biological orientations to language development. The programs mentioned above placed an emphasis on the word (sign) as an entity without respect to the various environmental contingencies which control the sign. Also, these programs have a tendency to minimize differences between the behavior of the speaker (signer) and the listener (observer). It is said that the essential feature of both is the understanding of the meanings of words. The two different behaviors are then characterized as simply the expressive or receptive manifestation of this understanding. From a behavioral point of view, however, this is quite unsatisfactory. It is true that the roles change rapidly in conversation, and it is also true that in some especially interesting cases a speaker is behaving primarily for himself as the listener. Still, for the most purposes, the distinction is an important one, especially when one's goal is to teach language behavior to someone in which it is absent or defective. To be able to say, "Open the door," under conditions where an open door would be a form of reinforcement is quite different from being able to open one when asked; and in the area of developmental disabilities, it is not at all uncommon to find individuals who have one but not both of these repertoires, as well as those who have neither.

Another distinction between the two repertoires is the degree to
which environmental support is necessary for responding. One does not need food present, for example, to talk about food (expressive); but in order to react to food receptively, it must be present. Also, there is a lack of specific topographies for corresponding stimuli; that is, receptive discriminations usually involve a scan and the same pointing response for each stimulus. It is impossible to affect the environment in the same manner as one does with an expressive repertoire. As a result, with receptive behavior, most of the different types of language cannot occur. It is impossible to ask for the names of things, their locations, functions, or instructions as to their use. Conversation, also, cannot occur with receptive skills nor can reading or writing. Receptive discriminations are important, but it has been a mistake to equate the receptive and expressive repertoires.

Skinner's (1957) analysis of verbal behavior may shed new light on the problem of teaching language to individuals in whom it is absent or defective. As previously stated, Skinner views language as behavior engaged in by a speaker (only) under the control of antecedent and consequent environmental events. This differs from the biological and cognitive approaches mainly in that it attributes verbal behavior to observable and measurable entities, rather than hypothesized internal processes or neuromusculature activity. Also, an environmental analysis allows us to make use of the mass amounts of data from research within the field of the experimental analysis of behavior.

In his analysis of verbal behavior, Skinner distinguishes between several types of verbal relationships. Before describing these, however, it is important to first provide a definition of verbal behavior.
Skinner defined "verbal behavior" as behavior which achieves its effect on the environment through the behavior of some other person. One can close a door by the appropriate hand and arm movement, which thus achieves this effect directly; or one can say, "Close the door," and in the presence of an appropriate listener, achieve the same effect indirectly. It is this indirect reinforcement that characterizes verbal behavior and which is responsible for many of the important features that distinguish verbal from non-verbal behavior. (Try to avoid confusing this use of "verbal" with "verbal" as synonymous with "vocal" or with "verbal" as contrasted with "quantitative" or "mathematical.") This identification of language behavior with behavior which is indirectly reinforced will include some topics which are not ordinarily considered linguistic and will exclude a few things that some might wish to include. However, it coincides well with the areas dealt with conventionally and has the advantage that it does not make use of terms such as "meaning" or "communication" that are, themselves, in need of further definition.

The Elementary Verbal Relationships

Skinner distinguishes between six types of verbal relationships: echoic, mand, tact, intraverbal, textual, and transcriptive. This classification is based on an analysis of both antecedent and consequent events. See Table I for a diagram and definitions of these relationships.

The Echoic Relationship
Table 1: The elementary relationships in B. F. Skinner's Analysis of Verbal Behavior.
<table>
<thead>
<tr>
<th>Controlling Variables</th>
<th>Response</th>
<th>Consequence</th>
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<tbody>
<tr>
<td>Establishing operation</td>
<td>Mand (asking)</td>
<td>Specific thing/action mandated</td>
</tr>
<tr>
<td>Non-verbal stimulus</td>
<td>Tact (naming)</td>
<td>Social (non-specific)</td>
</tr>
<tr>
<td>Verbal stimulus</td>
<td>Echoic, imitative, written (copy)</td>
<td>Social</td>
</tr>
<tr>
<td>With: Point-to-point correspondence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with formal similarity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal stimulus</td>
<td>Intraverbal (conversation)</td>
<td>Social</td>
</tr>
<tr>
<td>Without: Point-to-point correspondence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal stimulus (written)</td>
<td>Textual (reading out loud)</td>
<td>Social</td>
</tr>
<tr>
<td>With: Point-to-point correspondence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal stimulus (vocal)</td>
<td>Transcriptive (writing)</td>
<td>Social</td>
</tr>
<tr>
<td>With: Point-to-point correspondence</td>
<td></td>
<td></td>
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</table>
Echoic behavior is a type of verbal relationship where an antecedent vocal stimulus evokes a vocal response which has point-to-point correspondence with that stimulus; that is, the stimulus matches the response. A child's tendency to say "ball" as a function of someone else saying "ball" exemplifies the echoic. (In sign language, a signed stimulus may evoke a matching signed response; this also is a form of echoic behavior, except that it is non-vocal.) The reinforcement for echoic (or sign imitation) is usually some form of social approval. When a child behaves appropriately in response to the adult's, "Say dog," the adult is likely to smile or in some other way show his approval. Also, echoic behavior may be strengthened by the automatic conditioned reinforcement obtained for sounding like others in the environment (Sundberg, 1980). The echoic plays a major role in early language learning. Once an adult can get a child to make an echoic response to a sound or word, he can transfer control to the appropriate object. An adult may try to induce a child to say "dog" in the presence of a dog as a way of teaching him the name for that kind of animal (e.g., "That's a dog. Say dog." "What's that?" "Say dog."). A child acquires a great deal of his verbal repertoire in this manner. Echoic behavior continues to occur as an important form of adult language but is reinforced in other ways, as when we repeat a set of instructions to be sure we understood them.

The echoic relationship is an extremely important tool for teaching language to the individual in whom it is absent or defective. Once echoic stimulus control is established, it is usually quite easy to transfer stimulus control to the other verbal operants.
The Mand Relationship

The mand is a type of verbal relationship where the form of the response is controlled by an antecedent establishing operation (e.g., deprivation, aversive stimulation) and is characteristically reinforced by a specific object or event. The variables that control mands, establishing operations (E. O.'s) are described by Michael (in press) as:

Any change in the environment which alters the effectiveness of some object or event as a form of reinforcement, and simultaneously alters the momentary strength of the behavior that has been followed by that reinforcement.

People ask for the things and actions that they "want"; and in so doing, they specify the reinforcement. Asking for help, for example, specifies that some assistance would function as reinforcement; or asking someone to move specifies the reinforcement of a clear path. A large and very important part of the verbal repertoire involves this relationship.

The Tact Relationship

Skinner suggested the term "tact" for the type of verbal relationship where the form of the response (what is said or signed) is controlled by a prior non-verbal stimulus. The common non-verbal stimuli in a person's environment are objects (book, table, dog, pencil), actions (run, sit, talk, go), properties of objects and actions (red, fast, hot, sweet, curved), and relationships (above, in, large, open). The controlling stimulus for the tact need not be visual, although probably visual stimuli are the most numerous. To say "dog" on seeing one is an example of the tact, as is saying "dog" on hearing a dog barking even
though it cannot be seen. To say "smoke" as a result of smelling smoke is a tact, as well as saying "smoke" on seeing it. Saying "rough" on feeling a piece of sandpaper is a tact as is saying "hurt" as a result of painful stimulation.

As with echoic behavior, the tact is typically reinforced with some form of social approval in educational settings, and later by whatever action the listener takes with respect to one's tacting. In contrast to the mand, the response form is controlled by a prior non-verbal stimulus rather than what would function as reinforcement at that time. Thus, a child is taught to say "dog" as a tact when one can be seen, heard, felt, or smelled but not because one wants a dog. We ask others what they see or hear, and the information is useful to us if the response is in fact controlled as a tact. Also, we prompt mands by asking others what they want; but we expect the two types of behavior to be clearly distinguished.

The Intraverbal Relationship

In the echoic relationship, there is close correspondence between the controlling stimulus and the stimulus that the behavior produces. Thus, the echoic response sounds like the stimulus that determined the form of the response. When the child says "dog," it sounds pretty much like the same word that was spoken by the adult. But, we can also react to another speaker's (signer's) verbal behavior with responses which do not produce similar stimuli. Thus, on hearing someone say "table," we may have some tendency to say "chair." Such a tendency would probably not result in overt behavior under ordinary
circumstances; but it could be seen quite easily if instructions were given to, "Say the first thing that comes to mind when I say 'table'," as in a word association experiment. This type of verbal relationship is called "intraverbal" by Skinner, and it plays an important role in normal language. In the educational setting, much intraverbal behavior is developed, as in counting, reciting poems and singing songs, stating the properties of objects or events, listing the colors, the common shapes, "things to write with," etc. This type of training results in fairly strong tendencies for certain verbal stimuli to increase the probability of certain verbal responses other than echoic responses. Some are relatively trivial in their communicative effect, such as tendencies to say "butter" on hearing or seeing the word "bread." These "word associations" are not trivial, however, in their role in facilitating effective verbal behavior by a speaker or signer. Our intraverbal repertoires are quite important for rapid and effective speaking and listening. For example, it is relatively important that the verbal responses "butter," "white," "whole wheat," "eat," "meal," "toast," etc., all be readily available in our repertoire when bread is being introduced into a conversation. Intraverbal relationships between the stimulus "color" and such responses as "red," "blue," "green," etc., play an important role when we are asked to talk about the colors of objects.

The reinforcement for intraverbal behavior, as with echoic and tact behavior, is at first educational and social but eventually is related to its facilitative effect on one's own verbal behavior as well as the action the listener takes as a result of the speaker's behavior.
In learning a foreign language, the "translations" or "vocabulary" lists are intraverbal behavior. Thus, any tendency to say "mesa" as a result of seeing or hearing the English word "table" is intraverbal as is signing "table" upon hearing the English word "table." The stimulus is verbal, and the response is not an echoic response; that is, does not duplicate the properties of the stimulus. (Saying or signing either "table" or "mesa" as a result of seeing or touching a table would, of course, exemplify the tact relationship, since the form of the response, [either sign, English, or Spanish] is determined by the non-verbal stimulus of the table.)

The Textual Relationship

Textual behavior is a verbal relationship where a vocal response is under the control of a visual stimulus (written, typed, printed, finger spelled), and there is a match between the stimulus and the response. In some respects, this is like echoic behavior, except that the response does not produce a stimulus that matches the controlling stimulus. When you read, you do not produce a written visual stimulus but rather an auditory stimulus. In a sense, this auditory stimulus "matches" the written one but not in the strict sense of "match" since they are in different sense modes. Still, saying "dog" as a result of seeing "dog" written on a chalkboard seems more of a match than saying "cat" as a result of seeing "dog" written there--an example of intraverbal behavior. Skinner used the term "point-to-point correspondence" to refer to this "lesser" type of matching; thus, in textual behavior, the beginning of the stimulus is closely related to the beginning of the response, the
middle of the S controls, the middle of the R, and so on. In intra-verbal behavior, the controlling stimulus is the result of someone's verbal behavior (i.e., a spoken or written word or a manual sign); but it does not copy the stimulus nor does it have point-to-point correspondence with it. Textual behavior does not copy but does have point-to-point correspondence. There is a form of signing behavior which is analogous to textual behavior. Fingerspelling "dog" as a result of seeing "dog" written somewhere would seem to be quite similar to textual behavior; however, would not be completely analogous. A tendency to make the sign for "dog" (slapping the thigh) as a result of seeing the written word "dog" is not textual behavior since there is no correspondence of any sort between the parts of the stimulus and the parts of the response. It is not unlike a tendency on the part of a bilingual person to say "perro" (the Spanish term) on seeing the word "dog"; in other words, it is intraverbal behavior. This illustrates the point that sign language is much more like a foreign language than like a special form of English. There is a form of textual behavior for sign language. A notation system has been developed by Stokoe and his colleagues (Stokoe, 1958; Stokoe, Cronberg, & Custerline, 1965) which permits a point-to-point correspondence between written "cheremes" and a signed response. Research on this system has begun only recently.

The Transcripitive Relationship

The last of what Skinner calls the "elementary verbal relationships" is a type of verbal behavior where the form of a written response is controlled by a vocal verbal stimulus. Writing the word "boat" as a
function of someone saying "boat" is an example of transcriptive behavior. This relationship is commonly called taking dictation. As with textual behavior, there is the same "lesser" type of matching between the verbal stimulus and the verbal response. Also, an extension of Skinner's analysis to sign language would simply consist of writing in Stokoe notation under the control of signed stimuli. The reinforcement for transcriptive behavior (like the echoic, tact, intraverbal, and textual repertoires) is social, educational or automatic, conditioned reinforcement.

More Complex Verbal Behavior

What has been described so far are the elementary verbal relationships. These elements can be seen to constitute a large part of an individual's verbal behavior or the basic repertoire of the previously non-verbal person who is being taught some form of verbal behavior. But, verbal behavior quickly becomes more complicated, with long and rapidly emitted sequences, controlled by events and relationships of extraordinary complexity. Part of this complexity is due to behavior controlled by "private stimuli" (stimuli which arise within the body of the speaker but which are not available to anyone else). Some of it results from the fact that in most normal speaking or signing situations more than one controlling variable is present at a time and the resulting behavior is the joint product of this "multiple control." Finally, a good deal of the complexity of ordinary speaking or signing arises from the development of secondary verbal behavior, mands, and tacts which are controlled by other aspects of ongoing verbal behavior.
Skinner called this type of verbal behavior "autoclitic" behavior. Such behavior involves the self-manipulation of verbal behavior.

Skinner's analysis of verbal behavior has been available to the scientific community since 1947, when the Hefferline notes and William James lectures became available. And, it has been approximately 23 years since the book was published; yet, there have been no reported successful applications of his theory to the development of language training programs. The first reported attempt was by Spradlin (1963) who developed a language assessment procedure using Skinner's classification system. In a follow-up paper (Spradlin, 1967), he reported several difficulties with the system and since has abandoned its use.

Sloane and MacAulay (1968) published a book on operant techniques for language instruction. Certain chapters made use of Skinner's analysis for language assessment, programming, and data collection. But, the main impact of the book was its general emphasis on language as behavior which could be weakened or strengthened using operant principles.

There is a good deal of operant language research in the literature, but most of it has been concerned with the effects of consequent stimuli (differential reinforcement) and the use of imitation (matching a modeled response) to acquire new behaviors. In an early study by Rheingold, Gewirtz, and Ross (1959), the rate of vocalizations increased with applications of adult social reinforcement (smiles and touch) contingent on infant vocalizations and decreased during extinction. Weisburg (1963) demonstrated that an institutionalized three-month-old
infant's rate of vocal behavior also increased as a function of social reinforcement. These studies clearly demonstrate the effects of consequent stimuli on the rate of vocal behavior. Other researchers emphasize the use of reinforcement procedures within an imitation paradigm to modify verbal behavior (Lovaas, Berberich, Perloff, & Schaeffer, 1966; Brigham & Sherman, 1968; Sloane, Johnston, & Harris, 1968) of normal as well as retarded persons.

Several studies based on observations of normal language development have investigated the relationship between receptive and expressive behavior (Dickerson, Girardeau, & Spradlin, 1964; Fraser, Bellugi, & Brown, 1963; Guess, 1969; Guess & Baer, 1973; Mann & Baer, 1971; McCarthy, 1954).

The data seem to indicate that the expressive and receptive repertoires are separate but have a facilitative effect on one another; but under some circumstances, one precedes another and vice versa. However, as previously mentioned, from a Skinnarian analysis of language, the two repertoires should not even be compared.

Other language research reported in the behavioral literature is concerned with important fragments of a verbal repertoire, such as the role of generalization in language development (Hart & Risley, 1974, 1978, 1980; Menyuk, 1975; Stokes & Baer, 1977), teaching children to name objects (Carr, Binkoff, Kologinsky, & Eddy, 1978; Cuvo, Klevans, Borakove, VanLanduyt, & Lutzkor, 1980), and teaching children to ask for objects (Simic & Bucher, 1980).

Unfortunately, none of this research makes accurate use of Skinner's behavioral analysis of language. Some have used his terminology (Simic & Bucher, 1980) but have misinterpreted his analysis, but most have not
tried to relate their work on language to Skinner's analysis.

Most of the behavioral research on language does not involve the teaching of all aspects of language to individuals. (There are "behavioral" language training programs [Gray & Ryan, 1973; Guess, Sailor, & Baer, 1974; Kent, 1976], but all seem to avoid Skinner's analysis of verbal behavior.)

Part of the problem may be due to methodological constraints. The development of a verbal repertoire is a function of a wide variety of variables. There are often thousands of different topographies which become the dependent variables, and the independent variables are often complex and elusive. A child acquires a vocabulary quite quickly, and it may seem impossible to quantify this process. This situation has perhaps led researchers to examine only these aspects of language which could be analyzed within the framework of a multiple baseline, multielement, changing criterion, multiple probe, or reversal design. Language development simply cannot be thoroughly analyzed by the current applied methodologies. There is a need for a new research methodology.

A solution to the problem may be a methodology that was first proposed by Skinner (1956) in describing the events occurring in his early research activities. Essentially, Skinner proposed that the researcher's behavior should be under the control of the subject matter of interest; and it is the researcher's verbal behavior and ensuing changes in that behavior that become the main dependent variable in research. Skinner (1956) proposes:

It is time to insist that science does not progress by carefully designed steps called "experiments" each of which has a well defined beginning and end. Science is a continuous and often
disorderly and accidental process. We shall not do the young psychologist any favor if we agree to reconstruct our practices to fit the pattern demanded by current scientific methodology. (p. 232)

The study of language and language development does not lend itself to traditional methodology, and to confine one's scientific endeavors to only those aspects of the subject matter which "fit the pattern" is to deny one's self the possibility of discovery of new facts. Within a language training session, for example, a trainer may ask a student what he sees outside (an independent variable). The student responds. "bus" (the dependent variable); the topography of the next independent variable presented by the trainer can only at that time (after the student's response) be determined. It is, in fact, under the control of the student's response. "What do you do on a bus?" might be the next independent variable, but not if the student had responded with "tree" to the first question. In language training, the experimenter must put his behavior under the control of the subject's behavior. As a result, the student acquires more effective behavior; and the experimenter can better analyze the variables of which it is a function.

This methodology has been termed "radical methodology" by Day and his students (Bennett, 1978; Lahren, 1978; McCorkle, 1978) and appears in several other places in Skinner's writings (1957, p. 420) and especially can be seen in his autobiography, The Shaping of a Behaviorist (1980, p. 96).

The current research takes the form of a radical approach to research methodology. The main dependent variable is the experimenter's verbal behavior about language development and training. Other methodologies (multiple baseline, reversal, etc.) are contained within the
studies demonstrating experimental control. Five separate experiments were conducted over a period of five years, each with a group of non-vocal, retarded children. All children were taught sign language as a main form of communication, and the objective was to generate the most effective verbal repertoire. Each group received different training procedures as a function of individual differences and the experimenter's altered repertoire regarding language instruction.
CHAPTER II

Experiment 1

Introduction

Gardner and Gardner (1969) were the first researchers to conduct a study using sign language with a non-deaf organism, a chimpanzee named Washoe. Their success stimulated others to try a visual communication system with hearing individuals who were mentally impaired and had defective vocal behavior. By 1974, there were several reports of successful applications in the literature (e.g., Bricker, 1972; Creedon, 1975; Richardson, 1974); and programs for the use of sign language with this population were also available (e.g., Bricker & Bricker, 1974; Snell, 1974). The purpose of this study is to assess the effects of sign training using Snell's (1974) procedure on the language development of two individuals who have physiological damage to their vocal musculatures.

Method

Subjects and Setting. Carolyn was an eight-year-old girl who had cerebral palsy and as a result, had defective vocal musculature. She used a walker to move about the environment. Her manual dexterity was somewhat impaired, but she would quite readily attempt to imitate movement when asked to do so. Her receptive repertoire involved several complex discriminations (e.g., pick up the blue pen and put it in the big cup), but her expressive repertoire involved only pointing and vocal shrills. She was able to echo only the vocal sound "a."
Bruce was a 10-year-old boy who had physiological problems with his vocal apparatus which resulted in a tracheotomy. His manual dexterity was slightly impaired, but he would readily attempt to imitate movements when asked to do so. His receptive and expressive repertoires were quite similar to Carolyn's, as were his vocal skills.

Both children were students at the Kalamazoo Valley Multihandicap Center (KVMC) and were in the same classroom--the elementary component. Both were receiving speech therapy on a regular basis, but neither student had shown much improvement. The students' day consisted of 12 half-hour one-to-one sessions consisting of various motor and academic tasks (e.g., self help, matching-to-sample, fine motor). Most of the sign language training occurred in one-to-one situations in the elementary component of KVMC.

Procedure. Initially, the procedure outlined by Snell (1974) was the main guide in the development of individualized programs. This consisted of several stages: attending, motor imitation, basic receptive, receptive expansion, basic expressive, and expressive expansion. Data were collected on correct and incorrect responses emitted by the student.

Results and Discussion

The Snell program was abandoned quite quickly due to several complications. The attending and the motor imitation phases were somewhat effective, but the receptive phases seemed to take too long and only detracted from the final objective--expressive behavior. The program contains 44 signs which the child was supposed to be exposed to (either
through attending, imitation, or receptive training) before expressive training began.

With other methods, within one year, both children had acquired over 100 signs, most of which were the names for common objects and notions in their environment. The procedures used consisted mainly of expressive trials with prompts being faded out. This procedure (Sundberg & Horn, 1976) was presented in a workshop on a behavioral analysis of sign language (Sundberg, Michael, & Peterson, 1976). What follows is the procedure as it was written in 1976.

Sign Language Program. Prerequisite skills for entering the sign language program are as follows: (a) attending (e.g., in seat and looking at therapist); (b) being able to respond to single component, gross motor instructions (i.e., "Do this _____") with vocal as well as signed language (the student needing only to respond appropriately).

The student should be observed for several days prior to starting the sign language program. Record apparent reinforcers for the student as well as consistant behavior patterns.

Phase I: Expressive Signs.

A. If a student already has a "gestural language," i.e., pointing, waving, etc., start with his language and fade to the usage of signs. For example, if a student points to food and grunts, gradually shape successive approximations to the sign for eat. Model for the student by pointing at the food, sign, and say "food." If the student approximates, reinforce with food.

B. If a student does not have a gestural language, begin with signs that are functional for the student (some reinforcer). After physical imitation is established, begin with one sign (say "food"). Model the student's hand, if necessary, and reinforce successive
approximations with food. Once the child can command food, other functional signs should be introduced, such as water, restroom, play, or whatever you noted as reinforcers in your pre-program observation.

Phase II: Receptive Signs (Both Gestural and Non-gestural Groups).

This part begins with single component instructions using environmental context signs. Start with "sit" and "stand" using the same procedure of shaping. Follow this up with "come," "go," "stop," "walk," "run," "open," "close," etc. (Again, the specific signs you will use will depend on the individual student.) If the student fails to respond in this situation, have two therapists model the interaction and physically prompt the child (appropriately fade prompts).

NOTE: During the initial expressive and receptive phase, as well as throughout the program, any vocal/verbal behavior accompanying the sign should be reinforced.

As the student is learning to produce and respond to the signs in a structured environment, he must be required to use and respond to signs in his natural environment (at least approximations). As with any language, the reinforcement lies in its natural usage. Another extremely important aspect is that the student experiences a consistent exposure to the signs (i.e., one-half hour, three times a week is not enough). The staff should learn signs along with the student and require him to use them as well as a model for him. Be sure to always use the same words with the sign (i.e., avoid synonyms).

Phase III: Tacting (Naming).

Once a student can successfully mand reinforcers and follow single component instructions, tacting objects should be taught. Again, refer to your pre-program observations and find the objects which appear to be reinforcers to the student (i.e., fish, car, dog, cat, tree, etc.). The student should be able to produce
the sign upon seeing the items. (Again, physical prompts, molding, and reinforcing successive approximations are the key to success.)

Phase IV: Tacting.

Use colors, people, numbers, and other objects in the room.

Phase V: Backwards Chaining.

Once the student can produce signs for objects he wants, begin building sentence structure. Teach the student the sign "car" and now require "want car"; then, add pronouns, "I want car," etc. Also, add adjectives, "blue car," "big car," etc.

Phase VI: Prepositions

Start with "in" and "out" using demonstration models and successive approximations. Then, move to "above," "below," "on," "in front," "behind," etc.

Phase VII: Verbs

Start with physical actions, such as "push," "pull," "throw," "put," etc. Then, use verbs that are functionally relevant for the student.

Phase VIII: Question Words

Start with "what" by asking the student, "What is that?" After the student correctly responds, shape him to ask the therapist, "What is that?" Now, work on "who" using people the child knows; then, "where" using hidden objects.

Phase IX: Vocabulary Expansion

The stimulus cards from various language kits are good for developing vocabulary.

An important component of the program is assessing progress. An incorrect response is defined as a wrong or no response. An approximation is defined as producing more than half of the physical features of the sign. A correct response is defined as producing the sign required by the therapist. Data should be collected in structured settings as well
as for spontaneous usages and generalizations. Graph percentage of correct responses only. Upon meeting a criterion of two consecutive days of 80%, move to the next sign. By recording data, you will be able to determine the program's effectiveness and make any necessary changes.

The above outline is a general procedure for teaching non-verbal students sign language. It must be remembered that due to the population we are dealing with large variations in acquisitions should be expected. The most important aspect of the program is structuring it specifically for the student, finding his personal reinforcers and working with them.

Analysis of Experiment One

This procedure seemed to have several advantages over the Snell procedure. Mainly, it was suggested that the first signs taught be expressive and for those things which functioned as reinforcement for the individual. Also, a distinction was made between two types of expressive behavior—mands and tacts (Skinner, 1957). Still, however, there were several problems with the program. Mainly, there were major parts of Skinner's analysis of verbal behavior missing; and the expressive/receptive distinction still provided the main frame for the program. Perhaps for that reason, the repertoires generated by the new program were certainly an improvement but quite unlike the language development of other children.

1. Louise Kent invited the authors to include an expanded version of this program in the next edition of the Language Acquisition Program for the Retarded or Multiply Impaired, but the edition was never published.
The program presented in this experiment was the result of: (a) a course on Skinner's analysis of verbal behavior; and (b) exposure to the contingencies involved in language instruction. The two subjects in this experiment did not experience this procedure as written. The experimenters were constantly trying new techniques, methods, etc.; and as a result, exactly how and why the children acquired their sign repertoires was unclear. The data collection system only involved correct and incorrect responses under tact contingencies. The exact independent variables responsible for that acquisition were extremely difficult to quantify. The students had several different teachers, signed at home, and were always on a different reinforcement schedule, etc. However, our main interest at that time was to see if signs would work with these individuals; and if so, what were the best methods by which they could acquire signs.

There were other students in the elementary component of KVMC who used sign language as their main form of communication (due to deafness or they were using signs before they started the program). These students constantly presented a rich source of language problems which provided us with the opportunity to search for solutions.

Other language impaired individuals seemed appropriate for sign language, but it was often difficult to convince speech therapists and parents of the merits of signs. However, eventually, we were successful and were allowed to try signs with a hearing, non-verbal boy. The parents were quite willing to try anything that might help. This gave the experimenters an opportunity to start from the beginning for the first time; that is, since we were not clear on exactly what we were doing in
the earlier stages of the work with Carolyn and Bruce and since our other students already could sign, we had not had the opportunity to apply our program from the beginning.
CHAPTER III

EXPERIMENT 2

Introduction

This experiment began in November 1976, and what follows is the study as it was written and presented (Sundberg, Milani, & Partington, 1977).

Method

Subject

The subject was a ten-year-old male diagnosed as speech and language impaired and trainably mentally impaired. He had an extensive receptive vocabulary (e.g., he could follow multiple component instructions in finding hidden objects). During the school day, however, he spontaneously used only about five words which could be understood by the staff and spent approximately 25% of his day engaging in inappropriate behavior (consisting of aggression, screaming, or noisemaking). He had been receiving speech therapy sessions for two years, and a deceleration program for reducing the inappropriate behaviors was in effect at the outset of the current study.

Setting

The child was a student in the elementary component at the Kalamazoo Valley Multihandicap Center (KVMC). The study took place in a 1.7 m x
2.3 m x 2.7 m booth constructed of steel; there was a .3 m x .7 m one-way window. Experimental sessions lasted approximately 20 minutes and occurred at 9:00 a.m. and 12:30 p.m.

Observation

Prior to starting the training program, the experimenters spent several days observing the subject. Data were collected regarding the following:

1. Objects and activities which appeared to function as reinforcement (e.g., ball, tickling, food);
2. Objects with which the student came in contact in the various environments (e.g., table, chair, book);
3. Various behavior patterns and sequences of events (e.g., every morning the student hangs up his coat and goes to the bathroom before entering the classroom).

These data helped determine which signs would be taught first.

Training Program

The teaching of sign language was carried out in a sequence suggested by Skinner's (1957) analysis of verbal behavior.

Echoic Behavior. In learning to talk, a child normally acquires an echoic repertoire which is then used by adults in his environment to develop other verbal relationships. A non-verbal person, likewise, should first learn echoic (or for signs, imitative) responses for gross motor behavior (i.e., standing up, sitting down, bending over) as well as for fine motor behavior (i.e., touching finger tips together, making a fist). To generate this behavior, the command, "Do this," was used. One hundred
percent accuracy for two consecutive sessions (which consisted of 10 trials each) was required for progression to the next phase.

**Mands.** Skinner defines a mand as a verbal relation where the form of the response is determined by what has reinforced that type of response in the past. The common sense term "want" is used in identifying momentary effective reinforcement for an individual, so a mand is a type of behavior whose form is determined by what the speaker wants. To teach such behavior, six items were selected from the list of apparent forms of reinforcement: ball, water, tickling, food, pop, and restroom. At the beginning of the first session, in the presence of a ball, the sign for ball was made by the therapist; and the student was asked to imitate it. Then, the therapist said and signed "ball." The first trial consisted of signing and vocalizing "ball." The criterion for "correctness" of the sign involved three critical aspects: hand configuration, location, and movement (Stokoe, 1958). For vocal behavior, approximations were accepted (i.e., at least producing initial or hard sounds). The reinforcement for correct responses consisted of obtaining the item signed and vocalized (with the exception of "restroom"). (However, whenever possible, the subject was required to sign and vocalize the word before obtaining access to the restroom.) An incorrect response resulted in a correction procedure whereby the therapist said, "This is a ball (while signing "ball"). Sign ball." If the student responded correctly, he was reinforced; and the next trial began. If not, the procedure was repeated; and physical guidance was used. Signs were presented in a random order and increased to three per session after the first session. Two consecutive sessions of 100% accuracy on a single...
sign resulted in that sign being put on a review list and another sign added to the training group. (There were always three signs per session.) Following the acquisition of four signs, separate review sessions began.

Tacts. Skinner suggested the term "tact" for the type of verbal relationship where the form of the response (what is said or signed) is controlled by a prior non-verbal stimulus. The common non-verbal stimuli in a child's environment are objects (e.g., cup, table, door), actions (e.g., stand, sit, jump), properties of objects (e.g., hot, red, wet), properties of actions (e.g., fast, slow), and relationships (e.g., on, in, above). The same procedure described for teaching mands was used except that the reinforcement was social rather than access to the object or activity.

Intraverbals. The last of what Skinner calls the elementary verbal relationships is the intraverbal where a verbal response is controlled by a different verbal stimulus. A tendency to say "pencil" solely as a result of hearing someone say "paper" illustrates the intraverbal relationship. In the educational setting, many intraverbal relationships are developed; such as counting; reciting poems; singing songs; stating the properties of objects or events; listing the colors, the common shapes, "things to write with," etc. Some of the relationships are relatively trivial in their communicative effect, such as tendencies to say "butter" on hearing or seeing the word "bread." They are not trivial, however, in their role in facilitating effective verbal behavior by a speaker or signer. Our intraverbal repertoires are quite important for
rapid and effective speaking or listening. For example, it is relatively important that the verbal responses "butter," "white," "whole wheat," "meal," "toast," etc., all be readily available in our repertoire when "bread" is introduced into a conversation. Intraverbal relationships between the stimulus "color" and such responses as "red," "blue," "green," etc., play an important role when we are asked to talk about the colors of objects.

The training procedure consisted of signing to the student a previously mastered sign and the word (sign) "and"; for example, "Shoes and ___." If the student produced any sign which was related to "shoe," he was reinforced. An incorrect response was followed by a correction procedure in which the therapist completed the intraverbal relationship and asked the student to imitate him.

Tact Extension (Generalization). Following training on specific objects, actions, etc., it is important that the student be able to respond appropriately in the presence of new stimuli which resemble those previously named. If the student can sign "book," for example, in the presence of a small red book, it is desirably that the student also sign "book" in the presence of a large blue book. To train such a repertoire, 12 signs were divided into four equal groups. Nine therapists each picked two or three groups of signs and asked the student, "What is this?" in the presence of five untrained stimulus objects for each sign.

Speech Measures. Pre- and post-articulation tests were given. They consisted of a standardized test (Goldman & Fristoe, 1969) and a non-standardized test (imitative sound evaluation). Measures were obtained
on vowels, consonants, blends, and various combinations.

**Review Sessions.** Following acquisition for four signs, separate review sessions began. They were conducted each school morning and lasted approximately 20 minutes. The review consisted of two parts: first, the therapist vocalized, "What is the sign for _____?; and secondly, the therapist made the sign and asked the student for a vocal approximation. There were as many trials as there were signs on the review list.

**Sign Usage in the Home.** The parents were contacted, and they agreed to the procedure. They also agreed to use the signs in the home. To facilitate this, sign language flash cards (Hoemann & Hoemann, 1976) were sent home. The cards had drawings and verbal description of the signs on one side and the relevant English word or phrase on the other.

**Reliability.** Prior to the start of the review session, three reliability checks were made. Agreements over agreements plus disagreements was calculated, and this reliability was 100% on all observations. Because the review session would provide the necessary information concerning reliability of the repertoire being acquired, reliability checks on scoring were discontinued.

**Results and Discussion**

The student always responded correctly during the imitation phase and after two sessions, began the sign program. In Figure 1, cumulative signs acquired appear in panel two; and percent accuracy for review in panel one. These data are plotted across completed training sessions.
Figure 1: Sign acquisition for David.
Mands were acquired slightly quicker than the various types of tacts. However, overall acquisition was steady and not adversely affected by the introduction of a second training session (beginning with session 34). During the review sessions, the student usually responded at 100% accuracy. (During session 25 to 34, the student generally missed the same word, "spoon," due to unacceptable vocal approximations.)

Figure 2 contains the tact extension (generalization) results. Data were pooled from 1 to 8 sessions. The student always scored about 90%, and the responses became stronger as a function of continued exposure. Figure 3 contains the results from the articulation evaluations. Data are presented concerning number of sound errors; the lines above the bars are total possible errors. It is clear that articulation improved; however, these data are only suggestive due to the lack of experimental control.

The parents reported that the student used the signs in the home quite often, including attempts to teach the signs to his siblings. They also felt that his vocal behavior had improved considerably.

The first six signs, which were mands, were acquired quicker than other signs taught. This can be attributed to the special reinforcement available for that particular form of verbal behavior. Following mand training, acquisition was consistent, even when a second training session was introduced. This seems to indicate that the speed of acquisition is dependent on amount of training time. These parameters remain to be studied.

Data are not presented concerning the intraverbal training. However, the student acquired simple associations so rapidly that we were
Figure 2: Percent correct on generalization tests.
Mean Percentage Correct

Book, Shoes, Pants, Ball

Table, Paper, Cup, Food

Shirt, Door, Window, Pencil

STIMULUS GENERALIZATION

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Figure 3: Pre-training and post-training articulation errors.
Goldman-Fristoe

Vocal Imitation Evaluation

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not prepared to train more complex forms. Extensive study will be required to further develop such a training program. Such a study should probably begin by investigating complexity along two dimensions. First, it seems desirable that the student be able to produce a number of different responses for one stimulus. This probably could be trained by using the previously described procedure but reinforcing only novel responses. Second, research to determine the critical features for training increasing larger intraverbal relationships is needed.

The student's improvement in articulation could be due to a number of variables. However, some aspects of a sign repertoire seem to facilitate such behavior. First, as discussed earlier, attempts at vocal behavior have been punished because the listener could not understand the words and, thus, could not correct articulation when it is most critical. Signs, on the other hand, allow the therapist to recognize the attempted vocalization and immediately correct it; often the student learns to correct himself. Signs may then constitute a frame of reference for the student's vocal behavior.

A second explanation for improved vocal behavior may concern the sequencing of motor movements. Vocal behavior involves manipulating the right muscles at the right time. Signing also involves such manipulation, however, at a much grosser level. Often the components of the sign match the components of the word (as in initialized signs) providing even further assistance to vocalization. It also seems possible that signs could be faded out once vocal behavior becomes understandable. These points seem plausible; however, empirical testing is
necessary.

The therapists reported that having to learn the signs immediately before teaching them to the student presented no major problems. This is important because it is commonly asserted that all trainers must have a good knowledge of sign language. This usually results in postponing a sign program, sometimes indefinitely. Of course, someone involved in such a program must know signs to train the others.

The student's use of sign language outside of the training session consistently increased. However, attempts to directly measure such behavior were not reliable. In addition, his disruptive behavior decreased to zero levels. (However, a deceleration program was also in effect.)

Analysis of Experiment Two

There were several major improvements in this procedure. Mainly, the expressive/receptive distinction was dropped; and the "frame" of the program centered around Skinner's elementary operants. Establishing imitative (echoic) stimulus control was emphasized as the first step, and intraverbal training was added as a component (even though we failed to develop a data collection system). Tact extension procedures were also included in the program. Other additions to the program were the use of review sessions, trials at home, and speech measures. It was interesting to note our dissatisfaction with traditional reliability measures. They seemed not only to take valuable time but provide little

2. This experiment was awarded "Best Research Paper Submitted" by the American Psychological Association, Division 25, 85th Annual Convention, San Francisco, California, August 26-30, 1977.

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useful information (other than if our recorders were doing their jobs right). The review session provided the reliability or confidence (Skinner, 1957, p. 434) that the behavior was actually being acquired.

Still, however, there were several features missing from the program. Mainly, the conception of how to use the echoic, mand, tact, and intraverbal distinctions in language training was wrong. The first six signs were "mands," and the rest were "tacts," and no intraverbals were recorded. (Some were trained, but our recording system and understanding were not sophisticated enough.) The notion that a single topography could function as a mand, tact, or intraverbal was not incorporated into the program. Nor was the notion of transfer of stimulus control from one operant to another incorporated accurately. The sessions were also rigid (fixed number of trials for each sign) for experimental purposes and were quite unlike the events that seemed to occur with normal language development. Thus, although several hundred signs were eventually acquired, there seemed to be several peculiarities in the verbal repertoire. Also, the "natural" environment was neglected too much. Attempts were made at generalization and signing in the home, but it simply was not emphasized enough.

The interest at this point was to recycle the program incorporating the new procedures and try again to generate a more normal verbal repertoire. However, certain objections to the procedure were raised. Mainly, it was pointed out that the experimenters could not completely quantify all aspects of the independent variables; and the case was made that such documentation was necessary in order to proceed to more advanced levels. Also, no attempt was made to use accepted experimental
methods to compare the present procedures with others available. The next experiment involved an attempt to make such a comparison.
CHAPTER IV

Experiment 3a

Introduction

The sign language training program had become quite different from most commercially available programs. Mainly, the expressive/receptive distinction no longer provided a framework for the program. Rather, emphasis was placed on differences in the antecedent and consequent control of language (i.e., mands tacts, intraverbals, etc.). This difference in program structure was contested by some on the grounds that no empirical data were available to support this change. The shift in the structure was a function of the exposure to the contingencies involved in language instruction (Experiments 1 and 2) and discussions with colleagues. It seemed much more efficient to begin training with the generation of verbal responses (expressive), and the types of expressive behavior were distinguished by their difference in antecedent and consequent variable. Receptive discriminations were included in the program, but they were not emphasized as a major part of the training. The literature, however, contained a wide variety of viewpoints on this distinction (Bloom, 1974; Guess, 1969; Fraser, Bellugi & Brown, 1963); therefore, an empirical demonstration seemed necessary to substantiate the program change.

The purpose of this study was to determine the effects of receptive versus expressive sign training on language development. This study began in November 1977.
Method

Subjects and Setting. Two students from the Kalamazoo Valley Multihandicap Center (KVMC) served. Bob was nine years of age and had been a student at KVMC for one year. He exhibited virtually no verbal behavior but could make some simple receptive discriminations. His motor behavior was somewhat rigid, but he was quite ambulatory and easily reinforced. The cause of Bobbie's problems were unclear; there were no known physiological problems and although his vocal musculature was operative, he could only emit a few sounds and would do so quite infrequently. Each school day he received 12 half-hour one-to-one therapy sessions consisting of a wide variety of tasks (e.g., self help, fine motor, speech therapy).

Steve was seven years of age and had been a student at KVMC for one year. He also emitted virtually no verbal behavior and had poor receptive discriminations. He would vocally ask for "keys" several hundred times a day. His daily sessions were similar to Bob's; and also, the causes of his problems were unknown.

Procedure. The study began with a within-subject, within-session design. The dependent variables consisted of: (a) trials to acquisition of a sign (expressive and receptive; (b) probes on verbal development; (c) verbal behavior in the natural environment; (d) the Parsons Language Sample (Spradlin, 1963); and (e) vocal development. There were two values of the independent variable: (a) teaching 10 signs using the receptive procedures; and (b) teaching 10 signs using the expressive procedures. Expressive and receptive trials were randomly
alternated within the session. Reliability was taken each week on all measures.

Signs were divided into two groups (expressive and receptive), and daily sessions consisted of 10 trials on each of four signs (two signs from each group). The expressive procedure consisted of the therapist presenting the object and saying, "What is that?" A correct response was reinforced by giving the subject the object named and delivering social praise. An incorrect response was followed first by, "No," and an imitative prompt (i.e., "Do this."). If this was unsuccessful, a physical prompt was used (shaping hands). Both correction procedures ended with an additional, "What is that?" trial.

Data were gathered on motor (sign) and vocal behavior, which were broken down to their cheremic and phonetic elements, respectively.

The receptive procedure consisted of presenting three objects in front of the student and saying, "Touch the ____.", A correct response was reinforced by receipt of the object touched. An incorrect response was followed by a correction procedure consisting of pointing to the correct object and repeating the sign. The student was required to copy the therapist and if he failed to do so, was physically prompted.

Probes on verbal development were conducted every five sessions for each child. The probes were designed to test the strength of each of the verbal repertoires (i.e., mands, tacts, intraverbals). Samples of "spontaneous" verbal behavior were also taken during the school day. Also, the students were administered the Parsons Language Sample at regular intervals.

The training procedures were the main independent variable so it
was important to prevent any additional trials occurring outside of the training session (until the sign was mastered). Also, the individual training procedures were very structured, with all aspects of the independent variable being specified at the outset of the study.

Results and Discussion

Sessions were conducted each school day for approximately four months, and both boys failed to acquire more than five signs either expressively or receptively. There were continued problems with the methodology and with the basic experimental questions being asked.

In an attempt to show methodological control, independent and dependent variables were carefully specified and quantified. For example, the number of trials was held constant for each procedure. This proved to be a great difficulty. How could we be sure that the child was not receiving expressive or receptive language trials at home or outside of school. It was difficult enough to control for it in school. However, such control resulted in a situation quite different from normal language acquisition. We were removing the important role that the natural environment had in language development; and as a result, acquisition was extremely slow. But, such control was necessary in order to conform with standard methodological practices.

Such practices also resulted in a failure to account for the behavior of the subject as an independent variable. The training procedures were so structured that all of the $g^D_s$ (discriminative stimuli) presented by the experimenter were specified (for purpose of control) before the experiment. However, during the session, the subject's
response often had an effect on what the experimenter presented as the next SD; and it became increasingly difficult to quantify (thus account for) this interaction.

It slowly became clear that our experimental question was unanswerable. We were comparing apples and oranges. Our main dependent variable was the acquisition of language (i.e., mands, tacts, etc.), and our main independent variables were a procedure which trained language skills directly (expressive) and one that had little to do with language (receptive). Receptive behavior simply could not occur as mands, intraverbals, extended tacts, and several other important parts of language. There was no way the repertoire could develop.

The project was abandoned on the grounds that the expressive/receptive issue should play no role in the development of language training programs. The two seemed to be separate but facilitating repertoires. One must learn to emit mands and tacts, and one must learn to non-verbally react to the mands and tacts.

Second, it became clear that language acquisition could not be studied using the traditional behavioral methodology. This was due to the inability to control for all the independent variables that evoke and conseque verbal behavior in the natural environment. Also, it was impossible to control for the subject's history, which played a role in controlling behavior along with the contingencies of a given session. In addition, the subject's behavior became an independent variable which produced a change on the experimenter's behavior. Thus, the experimenter's next SD would be a function of both the subject's behavior and the guidelines specified by the procedure, and often they...
were incompatible.
CHAPTER V

Experiment 3b

Introduction

A second experiment was run simultaneously with the previous study. The experimenters had become quite convinced that sign language training was responsible for the rapid acquisition of language by those who entered the program. Still, however, some argued that this change could be due simply to the intervention procedures involved in language instruction. The question was asked, "Could the same results be obtained using only vocal behavior if the same systematic and rigorous intervention program were used?" The purpose of the present study was to investigate the effects of a vocal only procedure versus a sign-vocal procedure on language development. This project also began in November 1977.

Method

Subjects and Setting. Two students from the Kalamazoo Valley Multihandicap Center (KVMC) served. David was an eight-year-old hearing boy with Down's syndrome who had been a student at the Center for two years. He had virtually no vocal-verbal behavior but would quite readily imitate when asked to do so. John was an eight-year-old hearing boy who had been at the Center for three years. John had no obvious physiological problems but had failed to acquire much of a verbal repertoire. He could name about 10 items and ask for a few things using
vocal topographies. He would imitate movements when asked to do so and could follow simple instructions. The school activities of both boys were similar to those described in earlier experiments.

**Procedure.** The exact methodology for this experiment was similar to that of Experiment 3a. However, for this study, the values of the independent variables were: (a) a training procedure involving vocal only topographies; and (b) a training procedure involving sign and vocal topographies. The dependent variables were exactly the same as those of Experiment 3a.

Words were randomly divided into two groups (vocal and vocal/sign), and daily sessions consisted of 10 trails of each of four words (two words from each group). The vocal procedure consisted of presenting the student with the object and the question, "What is that?" A correct response was followed by receipt of the item and social praise. An incorrect response was followed by a correction procedure similar to the one described in Experiment 3a. The sign/vocal procedure was essentially the same except the therapist signed while presenting $s^D$s and consequences and required the student to sign responses.

As in the previous study, probes were conducted each week; samples of natural environment verbal behavior were taken; and the Parsons' Language Sample was periodically administered.

**Results and Discussion**

Sessions were conducted each school day for approximately four months, and both boys failed to acquire more than 15 words (both vocal and vocal/sign). Again, the main problem was methodology. The attempt
to quantify and control the independent and dependent variable forced us to exclude many of the contingencies occurring in the natural environment. Also, the structure of the procedure lacked the feature of "regular" language interactions.

General Discussion

Both studies convinced the experimenters that a special methodology was required for language research. That was perhaps the main development from those projects for we had little opportunity to study any language development. Several of these points and other methodological issues involved in language research were presented in a paper by Sundberg, Ray, & Rueber (1978).

Simultaneously, however, several additional projects were conducted on specific parts of the slowly developing Skinnerian language program. Braam, Sundberg, and Stafford (1978) conducted a study on the transfer of stimulus control in intraverbal training. As a result of this research, procedures were developed which trained increasingly complex intraverbal skills. Also, a data collection system for intraverbal training was developed. Stafford, Sundberg, and Braam (1978) conducted a study on the effects of mand versus tact training procedures. The results clearly demonstrated that the motivational properties associated with manding and the specific reinforcement characteristic of manding provide an important tool for the generation of a language repertoire.

The language program made several advances during that year despite the methodological digressions. The next edition of the program (Sund-
berg, 1978) had several additional procedures and analyses. The pro-
gram began with an emphasis on expressive (verbal) behavior rather than
receptive (non-verbal) behavior. There were several developments
within each of the elementary operants. For the echoic (imitative)
repertoire, several procedures for bringing behavior under copy con-
trol were described. Mainly, the motivational variables and specific
reinforcement of the mand were incorporated into training more system-
atically. Also, as a result of the study by Stafford, Sundberg, and
Braam (1978), more effective mand training procedures were described.
And, a program for generating more complex mands was described. The
training for a tact repertoire was also stated much more precisely and
contained several new categories and procedures, including a more
detailed analysis of tact extension. Largely as a result of Braam,
Sundberg, and Stafford's (1978) study, the intraverbal section con-
tained several new procedures. There was also a section on teaching a
textual repertoire. Also, a much more efficient data collection system
had evolved as a function of exposure to the contingencies of language
instruction (Ray & Sundberg, 1978).

Perhaps the main change that occurred in the theoretical nature of
the program during that year was the emphasis on a single topography
occurring under several types of control (e.g., mand, tact, intraverbal).
This possibility had not been well appreciated in the previous program.
Although the distinctions were made between the different repertoires,
the notion that a single word must be trained under mand, tact, intra-
verbal, and textual conditions was not clearly stated until Sundberg
(1978).
CHAPTER VI

Experiment 4a

Introduction

In the previous experiments (3a and 3b), the heavy emphasis on quantifying all aspects of the independent and dependent variables involved in language development resulted in a highly contrived and limited verbal environment. The acquisition of signs was extremely slow, and signing rarely occurred outside of the experimental setting. However, once the constraints of the design were dropped, language began to develop much more quickly. Since we were no longer trying to quantify all aspects of the procedure (e.g., number and location of trials), sessions could occur constantly throughout the day and under a much broader set of circumstances. These conditions were much closer to the contingencies involved in typical language acquisition (we termed this procedure the "shotgun" approach); but due to their constantly changing nature and the student's changed repertoire, the standard behavioral designs were inadequate.

The purpose of the present study was to assess the effects of sign language training on language development using a radical behavioral methodology (Skinner, 1956). Rather than specifying the exact values of the independent variables (e.g., topography of verbal SD presented, number of trails per unit of time) prior to training, the experimenter exposed himself to the contingencies involved in sign language instruction which in turn altered the trainer's repertoire regarding language
training procedures. Language acquisition involves thousands of topographically different antecedent-response-consequent relationships (unlike typical experiments) which can only be completely defined after their occurrence. Within a single trial, the subject's behavior functions as an independent variable which alters the trainer's behavior. For example, the trainer presents the $S^D$, "What did you see at the circus?"; and the student responds, "Blue," (for reasons unknown to the trainer). This response (I.V.) becomes an $S^D$ which will control the occurrence and topography (D.V.) of the trainer's next question (e.g., "A blue what?"). Had the student said, "Candy," when asked the first question, the trainer would have asked a different second question.

It is also impossible to accurately predict the rate at which an individual will acquire a verbal repertoire. Thus, future procedures can only be specified on the basis of history; and the nature of the experiment is such that this history is not present at the outset of the study. In a sense, each session consists of a new experiment. The flexibility of a radical methodology seems to allow for more typical language trails without sacrificing rigorous quantification of individual verbal episodes. This quantification is possible simply because it occurs after the interaction rather than before it. This experiment began in July 1978.

**Method**

**Subjects and Setting.** David was a nine-year-old boy with Down's syndrome and several physiological disorders, mainly kidney malfunctions and transplants. His life expectancy was quite short. He was a subject
in Experiment 3b and had acquired approximately five signs under mand/tact contingencies after five months of training but rarely emitted them outside of the experimental sessions. Matt was a six-year-old boy, also with Down's syndrome, who had been a student at the Center for approximately six months. Matt emitted about five signs under mand/tact contingencies and would occasionally emit them unprompted in the natural environment. Both boys could echo several sounds and blends, but few were under the other types of antecedent control. Their school day was quite similar to that of the students in previous experiments. Thirty-minute sessions were conducted each afternoon in the primary component of KVMC. Also, trials were interspersed with other trials throughout the day; and the parents were encouraged to conduct as many trials as possible at home.

Procedure. Both boys would readily imitate the trainer's motor movements so the first phase of the program (establishing echoic/imitative stimulus control) was not necessary. Also, since the beginning sign repertoires contained signs for their strongest forms of reinforcement (e.g., food, water), alternative forms of reinforcement were sought. The basic procedure consists of a transfer of stimulus control; that is, the objective was to transfer control from imitative to mand, tact, and intraverbal contingencies. For example, the trainer would say, "David, do this." "Car," (vocalizing and signing "car") while holding the car which David wants. David and Matt would immediately imitate the sign, and the next SD consisted of, "What is that?" in the presence of the car. The reinforcement for an approximation or a correct response is receipt of the car (along with social praise and occasionally an
edible). There are three antecedent variables involved in this procedure: (a) the trainer's imitative prompt; (b) the establishing operation involved in the car functioning as reinforcement (mand); and (c) the object itself (tact). Also, there are consequences, such as receiving the car, and the conditioned and unconditioned reinforcement. The objective in training was to fade out the antecedent variable number "a" (the imitative prompt) and bring the response under the separate control of "b" (mand) and "c" tact contingencies, thus the transferring of stimulus control.

A second individual collected data during the sessions. A code was designed to allow the observer to rapidly score the antecedents, topography, and consequence involved in the series of interactions between the student and the trainer. Each session began with a tact probe on previously acquired signs (eventually, probes were also conducted on mand and intra- verbal relations) and was followed by training on the new or partially learned signs. The probe consisted of presenting only a non-verbal stimulus (e.g., a ball) and the statement (spoken and signed), "What is that?" A correct response was consecutated with either the object, an edible, social praise, a toy, or a combination of different forms of reinforcement. An incorrect response was first followed by the verbal prompt, "Sign it"; if the response failed to occur, a transfer trial consisting of an imitative prompt was given ("Do this. "Ball (sign)." "What is that?"). If the response still failed to occur, physical prompting was used. Data were collected on each response emitted by the student and the trainer as well as the variables controlling their responses. Thus, the number of transfer
trials necessary to establish a verbal relation could be easily obtained. Reliability was assessed by other trainers who would also conduct probes during other parts of the school day.

The first five or six signs taught were signs for items and actions which were known to function as reinforcement. The next group involved objects and actions in the student's immediate environment. Simultaneously, attempts were made to transfer known mands and tacts to intraverbal contingencies. Future procedures could only be described as the students acquired more verbal behavior. The general framework of the program can be specified (e.g., following the establishment of several single responses under a variety of circumstances proceed to multiple topographies and multiple controlling variables), but the history of each individual plays an important role in more complex procedures, and these cannot be specified until after the history is established. Also, the trainer's repertoire changed as a function of discussion with colleagues and continued contact with the contingencies involved in language instruction.

Results and Discussion

Transfer of stimulus control from an imitative $S^D$ to the object usually occurred quite quickly (5-25 transfer trials) for both boys. Data on correct responding under the tact probe contingencies are presented in Figure 4. Following two months of training, Matt acquired approximately 70 signs under tact control while David acquired approximately 55. Since trials were conducted outside of the school and it was difficult (and often cumbersome) to record all those occurring
Figure 4: Number of correct signs on daily tact probe for Matt and Dave.
inside, it was impossible to specify all the variables responsible for such rapid acquisition of a verbal repertoire. However, the behavior of emitting a specific sign under a specific set of variables was nonexistent until transfer trials were conducted. Within a matter of minutes (and several trials), the student could emit the sign and would do so for other trainers as well.

During the acquisition of the first several signs, procedures were employed to transfer control to establishing operations. Transfer occurred quite quickly if there indeed was an establishing operation in effect (e.g., the student was hungry). Transfer could equally occur from either imitative or non-verbal stimuli. Often, establishing operations were contrived; for example, David could sign "rocking" under the control of a rocking horse but not when he wanted one (although rocking functioned as a strong form of reinforcement). The trainer held the horse firm while David was on it and asked, "What do you want?" Following an incorrect response, the trainer signed "rocking" which the student copied. Then, the trainer again asked, "What do you want?" and usually the student would sign "rocking," and the trainer would rock the horse. Following a few trials (interspersed by other trials) when the trainer would hold the horse and say, "What do you want?" the student would sign "rocking." Eventually, the verbal prompt, "What do you want?" was faded out; and the sign "rocking" occurred unprompted when the trainer held the rocking horse.

This type of trial was conducted as often as possible with the objective being to generate a functional mand repertoire. Both students acquired the mand frame "I want ____" and emitted it appropriately...
inserting the sign for the wanted object or action.

Transfer to intraverbal stimulus control was accomplished by fading out imitative and non-verbal prompts. For example, the trainer would say, "You throw a _____: and say and sign "ball" while holding a ball. The student would copy the sign response "ball," and the trainer would repeat, "You throw a _____"; if the student signed (or approximated) "ball," the trainer threw the ball as did the student. Again, transfer to the verbal stimulus occurred quite quickly; and trials were conducted with a large number of topographies under a wide variety of verbal S^D's (e.g., "You bounce a _____," "You roll a _____," "Bat and _____.").

Following the acquisition of a basic tact, mand, and intraverbal repertoire, the trainer began working on increasing the complexity of the controlling variables and the response topography required. Multiple tacts (e.g., non-noun, noun-verb) were taught by also using the transfer of stimulus control procedure. The trainer placed two objects on the table and asked, "What do you see?" An incorrect response was followed by either an imitative or non-verbal prompt; and following a correct response, the trial was repeated. Within a few trials, both students could tact any combination of objects. After 20 minutes of transfer training, they were able to tact up to five novel objects in one trial. The trainer then progressed to tacting object-action (e.g., ball roll); and again, using the same transfer procedure, acquisition occurred quite quickly. Training was also conducted on various combinations of tacts (agent-action-object) in order to generate sentences. Learning occurred as a function of frequency of transfer trials and
their related consequences.

The intraverbal repertoire was further developed by: (a) increasing the number of responses under a single verbal stimulus (e.g., SD: "What can you eat?" R: "Bread," "Potatoes," "Carrots."); and (b) increasing the number of controlling variables in the verbal stimulus (e.g., SD; "What can you eat in the morning?" R: "Eggs," "Toast."). Again, the transfer of stimulus control procedure was effective in generating this repertoire.

The next aspect of training involved an attempt to bring verbal behavior under the control of other students' verbal and non-verbal behavior. The students would correctly respond to the trainers' SD's but rarely interacted verbally with other students. A procedure was developed which consisted of giving one student (A) a collection of items which were highly desired by the other student (B). Student B was prompted to say, "I want ____," and student A was prompted to give B the desired object and received an edible from the trainer for doing so while student b obtained the object as a form of reinforcement. The roles were reversed several times, and the prompts were faded out; and within one session, the students were asking each other for novel objects. Prior to the training, data were collected on the frequency of verbal interaction in a secluded play area; and collection continued each day during this phase of training. The rate began at zero and as a function of the training, increased to several interactions per minute.

Transfer to textual stimuli was the next procedure employed. The student was presented with the written stimulus and asked, "What word
is that?" An incorrect response was followed by either an imitative or non-verbal prompt, and the trial was repeated. Transfer occurred quite quickly for both boys.

Table 2 contains the pre- and post-repertoires of each student. Note that training occurred for approximately one year for Matt and nine months for David who died due to kidney and other physiological disorders. Both boys acquired large sign-verbal repertoires in a relatively short period of time. It was clear that much of their "retardation" was simply a lack of language; and as language was established, the children became much more effective in the environment; and it became easier to teach them more complex skills (e.g., basic reading). Such rapid progress is atypical for language instruction. Sign language, however, seems to overcome many of the difficulties in language instruction, and the transfer of stimulus control procedure was quite effective in teaching a wide variety of verbal skills.

The procedures used evolved from discussions with colleagues and the contingencies of language instruction. The trainer often dropped (or changed) on-going procedures due to the discovery of better ways to generate the desired behavior. Prior to the study, such procedures could not have been described. Conducting sessions in the natural environment without constant data collection allowed for more "normal" verbal interaction. The constraints of data collection often seemed to interfere with procedures. That is, several different types of data sheets were designed and required to measure language development. The new procedures often evolved in the absence of systematic data collection. Once the procedure had stabilized, data sheets were formally
Table 2: The verbal repertoires of Dave and Matt. The upper panel contains pre-training data, and the lower panel contains post-training data.
### Pre-training

<table>
<thead>
<tr>
<th>Name, Age Labels</th>
<th>Behavior Problems</th>
<th>Echoic Repertoire</th>
<th>Imitative Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dave, 9 SSLI, Down's TMI</td>
<td>Withdrawal</td>
<td>10 phonemes</td>
<td>Fair</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Self-stimulation</td>
<td>No words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matt, 6-5 SSLI, Down's TMI, VI/HI</td>
<td>None</td>
<td>3 phonemes</td>
<td>Strong</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Post-training

<table>
<thead>
<tr>
<th>Name, Age, Training Time</th>
<th>Echoic Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dave, 9-10 10 months</td>
<td>Most phonemes</td>
<td>Mand frame</td>
<td>150</td>
<td>2-3 component - multiple $S^D$</td>
<td>25 words</td>
</tr>
<tr>
<td></td>
<td>Short sentences</td>
<td>10 per day</td>
<td></td>
<td>2-5 multiple responses</td>
<td></td>
</tr>
<tr>
<td>Matt, 7-6 13 months</td>
<td>Most phonemes</td>
<td>Mand frame</td>
<td>250</td>
<td>3-4 component - multiple $S^D$</td>
<td>50 words</td>
</tr>
<tr>
<td></td>
<td>Short sentences</td>
<td>3-4 component</td>
<td></td>
<td>5-10 multiple responses</td>
<td></td>
</tr>
</tbody>
</table>
designed and disseminated to other trainers.
CHAPTER VII

Experiment 4b

Introduction

Prior to sign training, both David and Matt were quite compliant and had very little inappropriate behavior. Also, they knew a few signs and had a strong imitative repertoire. The current study involved a set of subjects who had little vocal-verbal behavior and were non-compliant and disruptive. This study began in January 1979.

Method

Subjects and Setting. Howard and Kyle were five-year-old boys who had not been exposed to formal sign training but emitted some gestures as forms of verbal behavior (e.g., pointing and gestures for "come here"). They were receiving speech therapy daily; and as a result of eight months of training, they could emit several sounds and blends under echoic control, approximately 25 sounds under tact control, and several sounds and blends under mand control. The problem, however, was that their vocalizations were impossible to understand unless the listener had access to the controlling variables. That is, if the listener could see, hear, etc., the variables which were responsible for the student's response, he could sometimes understand the vocalizations. However, for the most part, their speech was unintelligible; and high rates of inappropriate behavior (e.g., screaming, tantrums) regularly followed failed attempts at communication. There were no known
physiological deficits, and it was not clear why these children failed to acquire a verbal repertoire. The boys were students in the primary component of KVMC, and their school day was very similar to that of the subjects previously described.

Procedure. After completion of the assessment phases of the program (i.e., current verbal functioning, forms of reinforcement, inappropriate behaviors, etc.), training began on the first phase of the program—establishing stimulus control. Training on other aspects (e.g., transfer to mand, tact, and intraverbal, multiple tacts) of language occurred as a function of the boys' progress. The procedures used were from the most current version of the language training program. Sessions were conducted, and training and probe data were collected in a manner similar to that of Experiment 4a.

Results and Discussion

Initially, the trainer worked with the boys simultaneously; but their disruptive behavior and difference in language acquisition required separate sessions and procedures. Howard had a very strong imitative repertoire and could copy novel configurations in only a few trials. Kyle, on the other hand, would usually refuse to do what the trainer asked so special procedures were required for each boy. For Howard, transfer training from a modeled $S^D$ to the object occurred in a few trials (3-10); and he began to acquire several signs a day. Transfer to mand and intraverbal variables also occurred quickly. After approximately two months of training, Howard exhibited about 75 signs
under tact control (Figure 5), 20 under mand control, and 25 under intraverbal control. Howard's acquisition was extremely fast, and he was quickly catching up to the boys from Experiment 4a (who started sign training six months prior to Howard), and he began participating in their sessions. Also, his disruptive behavior showed a clear decrease; but it was difficult to partition out the exact causes because deceleration procedures (e.g., response cost, time-out) were in effect along with language training.

Kyle's acquisition was quite slow compared to Howard's. Figure 5 shows only six tacts were acquired after one month of training. Kyle was extremely non-compliant, and sessions were often difficult to conduct. His inappropriate behavior clearly was incompatible with language acquisition. However, after four months of training, he acquired 41 signs under tact control, 10 under mand control, and about 20 under intraverbal control. His inappropriate behavior showed a clear decrease but still presented a major problem. Both boys showed continual improvements in articulation.

Howard and Kyle eventually received training on all the aspects of the program described in Experiment 4a. Their progress after seven months of training is presented in Table 3. After several months, the boys began to acquire new responses rapidly; in fact, it became quite difficult to continually measure their language acquisition. Howard, for example, acquired the sign "stuck" under the control of an object being stuck in a container (using the regular transfer of stimulus control procedure) in only a few trials. Then, later in the day, the trainer was taking Howard outside; and the door was locked. Howard
Figure 5: Number of correct signs on daily tact probe for Howard and Kyle.
CUMULATIVE NUMBER OF CORRECT SIGNS ON DAILY TACT PROBES

MONTHS

HOWARD

KYLE

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Table 3: The verbal repertoire of Howard and Kyle. The upper panel contains pre-training data, and the lower panel contains post-training data.
### Pre-training

<table>
<thead>
<tr>
<th>Name, Age</th>
<th>Behavior Labels</th>
<th>Echoic Repertoire</th>
<th>Imitative Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
</table>
| Howard, 4-10
SSLI, TMI, EI | Hyperactive, Non-compliant | 5 phonemes | Strong | 5 | 25 | 0 | 0 |
| Kyle, 5
SSLI, TMI, EI | Hyperactive, Non-compliant | Several phonemes and blends | Fair | 5 | 25 | 5 | 0 |

### Post-training

<table>
<thead>
<tr>
<th>Name, Age</th>
<th>Training Time</th>
<th>Echoic Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
</table>
| Howard, 5-5
7 months | Most phonemes, Short sentences | Mand frame several per minute 3-4 component | 500 | 3-4 component - multiple SD | 5-10 multiple responses | 20 words |
| Kyle, 5-7
7 months | Most phonemes, Short sentences | Mand frame several per minute 2-3 component | 300 | 2-3 component - multiple SD | 10-15 multiple responses | 20 words |
signed "stuck" unprompted. Also, once outside, Howard signed "stuck" (unprompted) under the control of a chain holding two picnic tables together. He seemed to show signs (e.g., smiles, laughter) of being automatically reinforced for a correct tact.

The results of this study indicated that sign language was a very important tool to the development of more complex language skills. In a period of approximately seven months, the boys advanced two to three years in language development (as measured by traditional assessments, e.g., Peabody Picture Vocabulary Test, Dunn, 1959). Articulation improved to the point where the boys stopped using the signs because others in the environment could effectively react to their vocal only responses. Signs seemed more effortful for the children and were voluntarily dropped. At this point, attempts to teach finger-spelling as a "bridge" between signs and vocal behavior were carried out. These procedures and their results will be discussed in Experiment 5.
CHAPTER VIII

Experiment 4c

Introduction

The subjects in Experiment 4a and 4b had some verbal behavior prior to sign training. The current study involved two girls who had virtually no verbal behavior at the outset of the study. This study began in January 1979.

Method

Subjects and Setting. Heather was a four-year-old girl who had been a student in the preschool component of KVMC for nine months. She had several sounds under echoic control (e.g., ah, ma, ba) but almost no sounds under tact, mand, or intraverbal contingencies. She was very compliant and had a wide variety of forms of reinforcement. Heather had almost no behavior problems nor any known physiological disorders. It was not clear why she failed to acquire a verbal repertoire.

Melanie was a four-year-old girl who had been a student in the preschool component of KVMC for one year. She engaged in high rates of screaming, head banging, and several forms of aggressive behavior (e.g., biting, kicking). Her inappropriate behaviors occurred almost constantly, and she showed almost no progress in daily academic programs. She had been involved in an extensive effort (by the current trainer) to teach her vocal behavior (in line with the arguments
against signs presented in Experiment 3b). At the beginning of that training, she had no sounds under echoic control and no motor movements under imitative control and, of course, no mand (other than screams, head banging, etc.), tacts, or intraverbals. As a result of four months of daily training (using the current version of the program), she acquired several sounds under echoic control, 13 sounds under mand/tact control, and no sounds under solely mand or intraverbal control. There was some progress, but it was too slow so approval for a sign program was granted. The school days for both girls were similar to those of the other students described previously.

Procedure. These girls benefited from several developments in the language training program. Mainly, the transfer of stimulus control procedures had become very refined as a function of Experiment 4a and 4b. (Even though Experiment 4c began simultaneously with 4b, the girls were always well behind the boys.) Also, additional components of the training program were developed and tested (e.g., training social behavior, multiple tacts, errorless programming). A final advance in this study involved a more precise data collection system. Also, verbal data were gathered under a wide variety of circumstances and by several people. (Data collectors were used in the previous studies but not as frequently as in this experiment.)

As with Howard and Kyle, sign training began with both students in one session; but due to the disruptive behavior, separate sessions were required.

The general steps in the procedure were the same as previously stated. Training began by establishing imitative stimulus control and
transferring control to mand, tact, and intraverbal contingencies. Again, the specific details of the more complex procedures could not be described until an initial verbal repertoire was established. The exact nature of these procedures depended on the student's repertoire at that time.

Data were collected within the session and several times across the day. A major attempt was made to conduct trials in the natural environment and to collect data on verbal behavior occurring in other environments. Staff were given in-service training on each child's progress twice a week. During this time, they were taught the new signs and given an opportunity to ask questions about the program. Data were regularly collected on vocal and sign babbling as well as "social" behaviors (e.g., interacting with other students and staff).

Results and Discussion

Both girls acquired signs very quickly. Table 4 shows the type of verbal relationship and the sign topography emitted by each girl. The numbers represent the days since sign training began. After the first day of training, each girl acquired a sign under the multiple control of the establishing operation (mand) and the non-verbal stimulus (tact). That is, stimulus control was transferred from the imitative prompt, "Do this," to the E.O. and the object. Both girls emitted an untrained generic extension on their first day of training. Heather signed "cracker," and Melanie signed "baby" under the control of novel and slightly different items. Also, the girls emitted the sign under the intraverbal control of the English word (e.g., "Sign cracker.").
Table 4: Heather and Melanie's verbal development in terms of the response topography and verbal relationship involved.
<table>
<thead>
<tr>
<th>Verbal Relationship</th>
<th>Heather Days from Start</th>
<th>Topography</th>
<th>Melanie Days from Start</th>
<th>Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiply controlled mand/tact</td>
<td>1</td>
<td>Cracker</td>
<td>1</td>
<td>Baby</td>
</tr>
<tr>
<td>English-sign intraverbal</td>
<td>1</td>
<td>Cracker</td>
<td>1</td>
<td>Baby</td>
</tr>
<tr>
<td>Mand/tact generic extension</td>
<td>1</td>
<td>Cracker</td>
<td>1</td>
<td>Baby</td>
</tr>
<tr>
<td>Pure mand</td>
<td>6</td>
<td>Eat</td>
<td>5</td>
<td>Baby</td>
</tr>
<tr>
<td>Pure tact</td>
<td>6</td>
<td>Book</td>
<td>6</td>
<td>Car</td>
</tr>
<tr>
<td>Two component pure mand</td>
<td>6</td>
<td>Eat cracker</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Pure intraverbal</td>
<td>33</td>
<td>Paper</td>
<td>34</td>
<td>Out</td>
</tr>
<tr>
<td>Mand frame</td>
<td>45</td>
<td>I want</td>
<td>60</td>
<td>I want</td>
</tr>
<tr>
<td>Three component pure mand</td>
<td>50</td>
<td>Want more raisin</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Four component pure mand</td>
<td>50</td>
<td>Want open bowl raisin</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Pure metaphorical extension</td>
<td>45</td>
<td>Book</td>
<td>36</td>
<td>Paper</td>
</tr>
<tr>
<td>Private event (self/other)</td>
<td>45</td>
<td>Pain</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Two component tact</td>
<td>90</td>
<td>Puppet-shoe</td>
<td>98</td>
<td>Movie-ball</td>
</tr>
<tr>
<td>Three component tact</td>
<td>101</td>
<td>Cup-spoon-ball</td>
<td>110</td>
<td>Sock-shoe-hat</td>
</tr>
</tbody>
</table>
This relation proved to be quite useful as a way to check and shape sign topographies.

The first observation of a pure mand (unprompted, solely under the control of the establishing operation) occurred five days after training for Melanie and six days for Heather. The first pure tact (unprompted, solely under the control of the non-verbal stimulus) occurred in six days for both Melanie and Heather. A two-component, pure mand ("eat cracker") was emitted by Heather also six days after training began. Melanie was never observed to make a multiple component mand unprompted. (It may be interesting to note that in traditional measures, mean length of utterance, Heather went from zero to two units in six days. This is typically considered an 18-month process.)

The girls continued to receive daily training on new signs and extensions. Figure 6 shows that after one month of training Heather emitted 17 signs under tact control and Melanie emitted 10. Training mainly consisted of transfer trials for new objects and actions. But, on the 30th day, a procedure to transfer stimulus control to other verbal behavior was implemented. As previously described, the procedure consisted of transferring control from either imitative or non-verbal controlling stimuli. For example, to teach the student to sign "paper" under the control of "you write on ____," imitative and non-verbal prompts are faded out. Both girls acquired this behavior quite quickly (to our surprise); and from that point on, intraverbal trials were interspersed with imitative, receptive, mand, and tact trials during training. The objective was to bring a single response (e.g., "paper") under as many different controlling variables as possible.
Figure 6: Number of correct signs on daily tact probe for Melanie and Heather.
Transfer began to occur quite rapidly when the trials were inter-
spersed with each other. This came to be called the "quick transfer"
procedure and was a major teaching technique.

Mand frames consisting of "I want _____" were emitted by Heather
45 days after sign training began and 60 days for Melanie. Once given
the name of a desired object, the girls would ask for it by emitting
the "I want" frame. Initially, it was prompted (e.g., "Sign 'I
want ____.'"); then, the prompts were faded out, and training on new
objects was given. Heather began to emit three- or four-component
mands (all unprompted) in less than two months of sign training. This
represents rapid language growth in traditional measures. The develop-
ment is often attributed to cognitive growth (Piaget, 1926) or to bio-
logical growth (Chomsky, 1965), but it seemed here to be clearly a
function of sign training.

The first pure metaphorical extension was observed 45 days after
training began for Heather and 36 days for Melanie. Heather signed
"book" solely under the control of a magazine, and Melanie signed
"paper" solely under the control of a book binding.

Heather acquired tacts for private events while Melanie did not.
The procedure consisted of conducting transfer trials in the natural
environment from imitative stimuli to private stimuli. Public accom-
paniment or collateral responses were used to assure that the pri-
vate stimulus condition was in effect (Skinner, 1957, p. 131). For
example, upon observing Heather bump her knee (public accompaniment)
and hold her knee (collateral response), the sign "pain" was shown to
her; and she was asked to copy it. Several trials were conducted with
the trainer "faking" the accident and prompting the student to tact it. In a few days, she began to reliably tact "pain" in her own body and on the part of others. She also learned several other signs for emotional or private stimulus conditions (e.g., cry, happy, sick). Melanie was never observed to emit such behavior unprompted.

After two months of sign training, both girls had acquired several forms and types of verbal relationships. Figure 6 shows Heather with 39 tacts and Melanie with 21. After four months of training, Heather had acquired approximately 100 signs and Melanie approximately 70.

Training on multiple tacts began 90 days after sign training began. Heather emitted her first unprompted multiple tact on the first day of training; Melanie emitted hers eight days later. The procedure previously described for training multiple tacts was used.

Heather acquired signs much faster than Melanie. Her repertoire grew quicker and seemed quite "normal." Melanie, perhaps due to her strong repertoire of inappropriate behavior, always required more trials even though she had begun (verbally) ahead of Heather). The girls showed a marked increase in babbling, both vocally and with signs. The process of automatic reinforcement was very easy to observe as the girls "playfully" emitted recently taught sounds and signs. Heather also emitted a great deal of "creative" behavior. For example, she was playing with a cup and putting imaginary things in the cup and asked several people to drink from the cup. Each time someone drank from it she would refill it. When asked, "What's in the cup," she signed "ice cream."

The girls acquired a fairly large verbal repertoire in only seven
months of sign training. Table 5 shows the various parts of the verbal repertoire and what behavior the students emitted.

It is clear that an individual can acquire a fairly complex repertoire in a short period of time with sign language. Such gains would have been impossible with vocal behavior alone. Also, Skinner's analysis seems to provide a useful framework to language assessment and programming. It is interesting to note that a great deal of what is often called "retardation" was eliminated in a very short time with language instruction. To what degree could other individuals labeled as retarded benefit from such training?
Table 5: The verbal repertoires of Melanie and Heather. The upper panel contains pre-training data, and the lower panel contains post-training data.
### Pre-training

<table>
<thead>
<tr>
<th>Name, Age</th>
<th>Behavior Problems</th>
<th>Echoic Repertoire</th>
<th>Imitative Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanie, 4-2</td>
<td>Self-abuse, Screaming</td>
<td>10 phonemes</td>
<td>Weak</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SSLI, SMI, EI</td>
<td></td>
<td>No words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heather, 3-10</td>
<td>None</td>
<td>15 phonemes</td>
<td>Strong</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SSLI, TMI</td>
<td></td>
<td>No words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Post-training

<table>
<thead>
<tr>
<th>Name, Age</th>
<th>Training Time</th>
<th>Echoic Repertoire</th>
<th>Mand Repertoire</th>
<th>Tact Repertoire</th>
<th>Intraverbal Repertoire</th>
<th>Textual Repertoire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanie, 4-9</td>
<td>7 months</td>
<td>Most phonemes</td>
<td>1-2 per minute</td>
<td>100</td>
<td>2 component - multiple SD</td>
<td>20 letters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Words</td>
<td>Single component</td>
<td></td>
<td>2 multiple responses</td>
<td>2 words</td>
</tr>
<tr>
<td>Heather, 4-5</td>
<td>7 months</td>
<td>Most phonemes</td>
<td>Mand frame several per minute</td>
<td>200</td>
<td>3 component - multiple SD</td>
<td>15 letters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Words</td>
<td>3-4 component</td>
<td></td>
<td>3-4 multiple responses</td>
<td>4 words</td>
</tr>
</tbody>
</table>
CHAPTER IX

EXPERIMENT 5a

Introduction

In all of the previous studies, there was a clear improvement in the students' articulation. There were several possible explanations given for this change, but none were identified as the main cause. One explanation involved the fact that often parts of the sign match parts of the vocal response and the former seems to exert some control over the latter. Signs, however, can never perfectly match the phonemes to be emitted. Fingerspelling, on the other hand, does allow for a much closer (although as with English letters, not perfect) point-to-point correspondence with the spoken sounds. It may be the case that articulation could be improved even more simply because of this close correspondence. Sequencing the fingers is much easier than sequencing the vocal muscles; and if vocal behavior can be brought under control of individual finger movements, then blends of finger movements and eventually whole words could be taught.

The purpose of this study was to examine a procedure for transferring stimulus control from an echoic stimulus to a manual letter. That is, teaching children to say "ah," for example not under echoic control but under the control of the manual symbol for the letter "A." This constitutes the beginning of what might be called textual behavior. A second purpose of this study involves the issue that this repertoire (textual behavior) is typically not taught to children until
after four to five years of language acquisition. The students in the current study, however, had virtually no language skills six months prior to the start of this study.

Method

Subjects and Setting

The two students from Experiment 4c, Melanie and Heather, served. The students knew several signs under a wide variety of stimulus conditions and could echo several sounds. Sessions were conducted three times a week, and transfer data were collected by a second observer.

Procedure

Sessions contained three types of trials: probes, echoic-to-letter transfer trials, and discrimination trials. Both girls participated in sessions simultaneously, and the types of trials were interspersed with each other and alternated between girls.

Probe Trials. Each session began with a series of probe trials. The trainer would extend his hand, form a configuration, and ask the student, "What sound is that?" Correct responses were always reinforced, and incorrect responses resulted in an echoic-to-letter transfer trial.

Echoic-to-letter Transfer Trial. First, the appropriate sound is modeled by the trainer while holding up the appropriate hand configuration; and the student is asked to copy it (e.g., "Ah, say 'ah'.") Then, the trainer, while still holding his hand up, asks the student,
What sound is that?" A correct response is reinforced, and an incorrect response results in a repeat of the procedure (e.g., "That's 'ah.' Say 'ah.'").

** Discrimination Trials.** These were essentially the same as probe trials except they occurred during the session rather than prior to any transfer trials.

**Results and Discussion**

The results of the three types of trials are presented in Figures 7 and 8 for Heather and Melanie, respectively. The top panel of both graphs shows the number of different sounds presented during the probes (open boxes) and the number correct (filled-in boxes) across sessions. Half-credit was given if a student corrected a response before a transfer trial was conducted. Heather's first correct response on a probe occurred at the beginning of the third session while Melanie emitted her first correct response at the beginning of the fifth session. The number of different sounds involved increased steadily to eight for Heather and seven for Melanie over 12 sessions. Number correct also steadily increased even though the discrimination was becoming more difficult.

The middle panel shows the number of echoic-to-letter transfer trials during each session. For both girls, there was a steady decrease in the number of trials even though the number of sounds was constantly increasing. Transfer of control began to occur quite quickly after the first few sounds were acquired. It seems that a history of transfer training can facilitate further transfer.

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Figure 7: The top panel contains the number of different sounds presented during the tact probe and the number correct. The middle panel contains the number of echoic-to-letter transfer trials, and the bottom panel presents the percent correct on discrimination trials. These data represent Heather's performance.
HEATHER

NUMBER CORRECT

NUMBER OF DIFFERENT SOUNDS PRESENTED DURING PROBES

ECHOIC-TO-LETTER TRANSFER TRIALS

PERCENT CORRECT DISCRIMINATION TRIALS

SESSIONS

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Figure 8: The top panel contains the number of different sounds presented during the tact probe and the number correct. The middle panel contains the number of echoic-to-letter transfer trials, and the bottom panel presents the percent correct on discrimination trials. These data represent Melanie's performance.
The bottom panel shows the percent correct on discrimination trials. Performance was well above chance for both girls. Melanie usually got about 50% correct on these trials, but the number of different hand configurations continually increased to eight (A, B, C, F, G, I, M, O) (12% chance). Heather reached 100% on these trials for the last two sessions, which involved seven different hand configurations (A, B, C, D, E, M, T).

Perhaps the most interesting aspect of these data were that such individuals could acquire basic letter discriminations in such a short period of time. This may simply point out that the procedure of transferring stimulus control from an echoic stimulus to a manual stimulus is an effective procedure for generating a type of textual behavior. The procedure makes no appeal to "cognitive levels" or "reading readiness," both of which would have predicted failure.

Heather required fewer transfer trials than Melanie which was consistent on almost all new verbal relationships. Both girls began to copy the trainer's manual letter (unprompted) and showed a fair amount of appropriate manual and vocal babbling (e.g., during play sessions, they would hold up the manual letter "B" and say, "Ba, ba, ba."). This seemed to be maintained by automatic reinforcement (Sundberg, 1980). Neither girl showed any untrained transfer to written letters; but in a few trials, they were able to produce the appropriate sound under the control of the written letter, thus, true textual behavior.
CHAPTER X

EXPERIMENT 5b

Introduction

Fingerspelling may improve articulation because of the close point-to-point correspondence with spoken sounds. This match could allow an individual to sound out a word; that is, if he can spell the word and if he can pronounce the appropriate phonemes and blends (Experiment 5a), then he can correct or more effectively control his vocal behavior. For example, a picture of a cat may evoke the "ca" phonemes; but if the individual (or a trainer) fingerspells C-A-T and if the student's vocal behavior is under the control of each letter, then the student should be able to emit the word as a complete unit.

In order to assess this situation, a student was taught to produce most of the sounds under manual control (Experiment 5a) and most of the manual configurations under vocal control. Blends were also taught to the student. The purpose of this study was to assess whether vocal behavior was stronger under tact contingencies if echoic transfer training includes fingerspelling as an additional independent variable. (This study was actually run prior to Experiment 5a but with different subjects.)

Method

Subjects and Setting

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David, the student from Experiment 2, served. He knew several hundred signs and began to stop using them due to improved articulation. However, he rarely emitted all of the phonemes of a word. Sessions were conducted three times a week in a booth at KVMC.

**Procedure and Design**

**Pretraining.** The student was taught to: (a) produce the appropriate phoneme under the control of the manual letter; (b) produce the appropriate manual letter under the control of a vocal phoneme; (c) produce appropriate blends of phonemes under the control of multiple manual letters. This training was accomplished using the transfer of stimulus control procedure described in Experiment 5a. The training took approximately three months.

**Training.** A design which combined the aspects of a multielement, multiple baseline, and reversal design was used. The dependent variable consisted of articulation (measured by phonetic speech sounds) under the control of tact contingencies. There were two values of the independent variable: (a) echoic training with a vocal stimulus (e.g., "Say puzzle."); and (b) echoic training with a vocal and fingerspelled stimulus (e.g., the therapist would simultaneously say and fingerspell the critical word, "Say stapler/S-T-A-P-L-E-R."). Tacts which were not in the student's repertoire were picked and matched for articulation difficulty. After criterion was met on one value, the contingencies were reversed (i.e., "puzzle" would now be vocalized and fingerspelled and "stapler" only vocalized). The procedural events occurred in the

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following manner (Table 6): (a) a tact probe (e.g., "What is that?") totally under the control of the non-verbal stimulus; (b) an echoic trial (e.g., "Say puzzle."); and (c) an echoic-to-tact transfer trial (e.g., "What is that."). Then, the procedure was repeated with a second word; but fingerspelling was included in the echoic trial. The procedure involved the same steps as above: (a) a tact probe (i.e., "What is that?"); (b) an echoic trial with the word fingerspelled (e.g., "Say stapler/S-T-A-P-L-E-R."); and (c) an echoic fingerspelling-to-tact transfer trial (i.e., "What is that?"). Then, the trainer returned to the first word. Data were collected on articulation during the tact probes.

Results and Discussion

Sample data are presented in Figures 9 through 12. Percent correct phonemes are graphed across probe trials. Each graph represents one session. In each case, articulation was stronger when fingerspelling was used in training. A reversal of conditions always resulted in improvement in the previously vocal only word and only occasionally did the removal of fingerspelling result in a decrease in articulation once the response was acquired.

The data show that fingerspelling improved articulation under tact contingencies. This improved behavior seems to be due to having the child's vocal behavior under the control of manual movements; when such control is absent, behavior weakens. Also, the student acquired the previously unknown tact relationship much faster with fingerspelling. These aspects of the study have been replicated in a study by Rueber.
Table 6: Flow chart of the procedure.
Figure 9: Percent correct phonemes emitted on tact probes for vocal words and for vocal/fingerspelled words.
Figure 10: Percent correct phonemes emitted on tact probes for vocal words and for vocal/fingerspelled words.
Figure 11: Percent correct phonemes emitted on tact probes for vocal words and for vocal/fingerspelled words.
Figure 12: Percent correct phonemes emitted on tact probes for vocal words and for vocal/fingerspelled words.
Sundberg, and Legg (1980).

In conclusion, fingerspelling seems to provide an important bridge between sign language and vocal behavior. In the past, students have moved too quickly from signs to vocal only and vocal behavior weakens. Fingerspelling seems to strengthen vocal behavior during that transition.
CHAPTER XI

General Discussion

The Use of Sign Language

This series of experiments, with each study a systematic replication and extension (Sidman, 1960) of the previous studies, provides empirical support for the use of signs as a form of language for hearing, non-vocal persons. The sign training program was effective in generating a verbal repertoire for individuals with a wide variety of handicaps (e.g., autism, Down's syndrome, retardation). Despite long histories of failure in language instruction, each student acquired a fairly large sign repertoire in a short period of time; in fact, often faster than typical children acquire vocal language. The only major difference noted across handicaps was the number of training trials necessary to generate the repertoire; otherwise, the data look similar. All students showed a clear improvement in articulation; that is, there was an increase in the frequency of sounds emitted as well as a change in the quality of those sounds. There were several variables responsible for this improvement, but most were related to the sign training (e.g., the opportunity to correct articulation when the trainer knew what the student was trying to say via sign). Also, there was a clear decrease in the inappropriate behavior that some of the students emitted. This, like vocal improvement, was a function of several variables; but, again, most were related to the sign training (e.g., failure to communicate often resulted in disruptive behaviors;
signs decreased such conditions).

Recently, a review of the literature on the use of sign language with normally hearing retarded individuals was published (Poulton & Algozzine, 1980). The authors, following a review of several professional journals, cautioned against the use of sign language based on the lack of empirical data. They conclude:

The literature specifically supports the notion that manual signing can facilitate word-object associations. It does not, however, support the contention that retarded persons attain a functional communication system based on manual signing or that manual signing has become a primary mode of communication for nonverbal retarded individuals. (p. 51)

The data from the current series of experiments seem to provide the needed support. However, a closer look at previous studies on sign language and a comparison to the current study may account for the conclusions of Poulton and Algozzine.

The behaviors trained by the authors cited by Poulton and Algozzine (1980) consisted essentially of tact relationships. That is, the typical procedure involved teaching a student the names of things. And, when a student could produce the sign (unprompted) that corresponded with the object and could touch the object, he was given credit for "knowing the meaning of the word." Then, it was expected that the student would "use" his signs to "express his needs and wants." However, Poulton and Algozzine (1980) object to the facts that the students were not "using" their signs outside of training and their sign repertoire was not like that of typical children. This, of course, was because the researchers only taught one part of a verbal repertoire and expected the students' "cognitive equipment" to do the rest. This
obviously represents the cognitive approach to language development, which has long dominated language programming efforts.

The current study involved a completely different set of training procedures. A verbal repertoire was analyzed in terms of antecedent and consequent events controlling behavior, and training consisted of establishing verbal relationships. Skinner's (1957) analysis clearly partitioned the types of verbal relations and served as a guide in developing procedures for bringing verbal behavior under stimulus control and transferring that control to other variables. No appeal was made to "cognitive processing systems" or "language acquisition devices." Yet, a "typical" verbal repertoire was generated. Such appeals to "inner agents" seem to have led researchers and educators astray in the recent past.

There are several other features of the current program which may have facilitated learning. Most of the training involved few errors by the students. Once stimulus control (over motor behavior) was established, transfer could occur almost error-free by the use of delayed or faded prompting (Terrace, 1963; Touchette, 1971). The strong emphasis on the natural environment allowed the trainees to take advantage of the powerful contingencies operating throughout a student's day, especially since the terminal objective was to bring verbal behavior under the control of those contingencies (Spradlin, 1966).

The methodology employed may also have facilitated acquisition. Traditional behavioral designs confine experimental activity to procedures which have been specified prior to the experiment. With language training, it is usually difficult to specify all the variables prior to
training. The problem is exacerbated by the fact that verbal relations can only be identified after their occurrence; and once they have occurred, they can function as independent variables in future relationships. Thus, it is impossible to specify more advanced aspects of language training until after a verbal history is established and analyzed.

A radical methodology allows one to avoid the rigorous attempts to quantify all the independent variables prior to their occurrences (e.g., 15 tact trials a day) or control for outside independent variables (e.g., no trials outside of the session) and seems more functional for the acquisition of complex behaviors. Also, a radical methodology is flexible enough to allow changes in the procedures during the study (e.g., discovery of new transfer techniques) and results in faster acquisition and a more skillful trainer (due to the contingencies of reinforcement involved in finding more effective ways of training and being allowed to employ them without aborting the project).

Perhaps the most interesting aspect of this methodology is that the main dependent variable is the behavior of the experimenter, which is evoked and altered as a function of contingencies which he comes in contact with. The present study represents an example of how such contact with the contingencies can change the repertoire of an individual. As a result of direct interaction with the contingencies of language instruction, rules have been generated which can be passed on to others who would like to be able to do similar things. Such rules often "short circuit" the learning process, and effective behavior can occur immediately rather than gradually (Skinner, 1969, 1974). The experi-
menter's verbal behavior about his subject matter is an important aspect of science. Facts, rules, laws, maxims, and so on are the products of such endeavors and allow us to behave more effectively. The point of science, according to Skinner (1969) is "to analyze the contingencies of reinforcement found in nature and to formulate rules or laws which make it unnecessary to be exposed to them in order to behave appropriately" (p. 166). A radical methodology has allowed the experimenter to expose himself to such contingencies and formulate rules of language instruction. Many of these rules have been presented in the current paper, but more complete descriptions of them may be found in the language training manual by Sundberg, Ray, Braam, Stafford, Rueber, and Braam (1979).

A complex set of rules evolved in regard to data collection during the course of the current study. The final system provided the experimenter with the topography of behavior and antecedent events and the consequences of all verbal episodes during a session. Real time measures were used to derive response rate, and latency data were obtained as often as possible. Several attempts at a computerized data collection have been made with fair success. However, the system is far from complete. Computer programs can be designed to control and record contingencies involved in language instruction, collect and analyze rate and latency data, and serve as training systems to pass on the rules of teaching language. Programming languages, such as SKED (Snapper & Inglis, 1980) and LEARN (VanderLugt, 1974) will allow for a close analysis of the contingencies, pointing out changes otherwise unobserved.
A thematic line of research on sign language and Skinner's analysis of verbal behavior has been presented. During the course of this study, approximately 30 other projects on specific aspects of the program were conducted (e.g., Bell, Sundberg, Rueber, & Yutzy, 1979; Braam, Daeschlein, & Braam, 1979; Braam, Sundberg, Ray, Braam, Stafford, Rueber, Thompson, Stang, & Jackson, 1979; Hall, Sundberg, & Stafford, 1979); and each project seems to generate new ones. It is impossible to determine the long-term effects of a behavioral language program, but it is easy to speculate about possibilities.
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