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A Comparison of a Topography-Based Language System and a Selection-Based Language System

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A COMPARISON OF A TOPOGRAPHY-BASED LANGUAGE SYSTEM AND A SELECTION-BASED LANGUAGE SYSTEM

by

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AND A SELECTION-BASED LANGUAGE SYSTEM

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This study examined whether it was easier for developmentally disabled individuals to acquire a topography-based or a selection-based language system. Four moderately and mildly mentally retarded adults served as subjects. Each of the subjects was taught to tact an object by either pointing to its corresponding symbol (with the selection-based paradigm) or making the corresponding sign (with the topography-based system). They were then taught an intraverbal relation by either selecting the symbol, or making the sign which corresponded to an auditory stimulus. Finally, the subjects were tested for the emergence of stimulus equivalence classes. Each subject was trained and tested with one paradigm, and then trained and tested with the other. The results show that sign language was acquired more easily than symbol board language, as measured by the acquisition of tacts, intraverbals, and the formation of stimulus equivalency.

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CHAPTER I

INTRODUCTION

Topography-based and selection-based verbal behavior are often considered to be equivalent forms of the same underlying language process. But, according to Michael (1985), there are important differences between these two types of verbal relations. This, he suggests, is of special significance when verbal behavior is being developed in those whose verbal repertoires are seriously lacking.

When referring to topography-based verbal behavior, the topography of the response is an important aspect of the verbal relation (Michael, 1985). The topography distinguishes one response from another. This is the case for speakers, writers, and users of sign language. Writing "dog" consists of a different topography than writing "cat." Saying "dog" involves a different action of the vocal musculature than saying "cat" (as well as a different controlling variable). "The unit of verbal behavior can be described as an increased strength of a distinguishable topography given some specific controlling variable" (p. 2).

Stimulus selection-based verbal behavior does not involve distinguishable topographies, but it results in distinguishable stimuli for the listener. Selection-based verbal behavior consists of pointing, touching, or indicating a particular stimulus. This leaves a distinguishable response product for the listener just as topography-based verbal behavior would. Michael (1985) points out that the effects on the listener may seem quite similar, but, from the producer's perspective, they are quite different.

Perhaps the best example of selection-based verbal behavior is the lexigram selection system used by Rumbaugh (1977) in his work teaching language to a chimpanzee (the Lana project). Each lexigram was embossed on a computer key and the chimpanzee subject learned to interact verbally with the equipment and the experimenters by pressing single keys or sequences of keys.

Epstein, Lanza and Skinner (1980) also used a selection-based system when attempting to simulate with pigeons some of the findings with chimpanzees.

Symbol or picture boards as used with the developmentally disabled (particularly those with serious motor disorders) is another example of a selection-based language system (Bliss, 1965; Hurlbut, Iwata, & Green, 1982). Such systems typically consist of a small board, such as could be placed on one's lap, on which are several rows of symbols or pictures to which the user points as a way of responding verbally. In some cases the stimuli are actual pictures of objects or events, such as a picture of a glass of milk, but in other cases abstract symbols are used, such as a series of lines arranged horizontally, vertically and diagonally.

Speech therapists often favor this type of language training for nonvocal clients over the teaching of manual sign language, even when there is no manual motor skill deficit. One reason for this preference is that staff and parents do not have to learn any new language system, such as would be the case if the client was learning a form of the sign language of the deaf. Another reason is that the language user does not have to be taught any complex motor skills--most of such clients have already learned to point to various things in interacting with staff or parents. Still another reason is the clarity of the stimulus produced by the language user--the picture pointed at as contrasted with a poorly executed manual sign.

For these and other reasons, many professionals feel that language systems based on symbol boards or picture boards, which are selection-based systems, are acquired easier than language systems based on signs, which are topograpy-based systems. However, as pointed out by Sundberg (1987), there are several linguistic limitations inherent in a symbol or picture system and these limitations may have a major impact on language acquisition and use. The first limitation is the necessity of depending on auxiliary equipment. It is not always possible to have a picture board by your side. Skinner (1974) points out that an important facilitating feature of speech is that it is free of environmental supports. "One needs a bicycle to ride a bicycle but not to say bicycle" (p. 100). Similarly, one needs a symbol of a bicycle to select bicycle but not to sign bicycle. Also, according to Sundberg (1987), abstract concepts such as verbs, prepositions, and adjectives are difficult to portray clearly in symbol form. Perhaps the major problem is that, with a pointing system, the response topography is the same for each word. No specific muscle movements get linked with a specific controlling variable. Michael (1985) considers this an important feature of topography-based verbal behavior.

Michael (1985) also points out that selection-based verbal behavior involves a conditional discrimination (two primary controlling variables). For example, a stimulus (such as a request) alters the controlling strength of another stimulus (a picture or symbol on a board) over a non-distinctive response such as touching or pointing. Topography based verbal behavior involves only one primary controlling variable, a stimulus merely alters the distinctive response. Michael adds that additional controlling variables, such as establishing operations, audience characteristics, etc., make unconditional discriminations actually conditional, but this only means that selection-based verbal behavior has a further degree of conditionality.

Michael (1985) notes that another difference between the two types of verbal systems is that topography-based verbal behavior always involves point-to-point correspondence between the response and the response product. For example, "when one speaks there is a correspondence between the details of the vocal musculature action and the relevant details of the auditory stimulus that results" (p .3). This is not the case with selection-based verbal behavior since all responses are topographically equivalent.

Selection-based verbal behavior also requires an effective scanning repertoire. The various visual stimuli ussually are not all visible at the same time. A normal adult has a systematic way of scanning the stimulus selections. For example, from left to right, from top to bottom. For those who do not have this systematic approach in their repertoire, it would be easy to overlook the correct stimuli. Also, if the scanning takes a long time, the effectiveness of the controlling variable could be lost.

In conclusion, Michael (1985) suggests that these differences (conditionality, lack of point-to-point correspondence, and the need for an effective scanning repertoire) may make selection-based verbal behavior harder to acquire, less likely to be controlled effectively by motivational variables, and more likely to be interfered with, than topography-based verbal behavior.

If these differences are indeed significant, then there is need to compare empirically the two systems with regard to such factors as: speed of acquisition, accuracy of responding (percentage of correct responses), generality, maintenance, and spontaneous usage.

The main purpose of this study was to compare the two systems by teaching tacts and intraverbals. Speed of acquisition and accuracy of responding were used as measures. A secondary purpose was to compare the two systems with regard to the development of stimulus equivalency classes.

Stimulus equivalency has been an active research area over the last 20 years and its importance to language development has been clearly stated. It is not, however, agreed upon as to whether language is a prerequisite for the demonstration of stimulus equivalency, or whether the properties of equivalence are a prerequisite for language. If verbal relations such as the tact are indeed necessary prerequisites for the formation of equivalence classes, then it would seem important to know if tacts are acquired easier with one language system than with the other. Also, if stimulus equivalency is demonstrated more easily with the language system in which the tacts were demonstrated more easily, then one might conclude that the tact is a prerequisite for the formation of equivalence classes.

The efficiency of equivalence paradigms in generating new performances has obvious language acquisition implications. The equivalence class formation process is fundamental to linguistic competence because it makes it possible for words to mediate the emergence of new behavior that has never been taught directly (Sidman, 1977).

It has been suggested that the formation of equivalence classes leads to concept formation (Dixon & Spradlin, 1976; Spradlin, Cotter, & Baxley, 1973; Spradlin & Dixon, 1976), when concept formation is defined as a group of stimuli which control common responses. This implies great practical value in the area of language development. For example, if a child is taught to label bananas, apples, and peaches as fruit (Spradlin et al., 1973), and then taught that apples and peaches grow on trees, he may, without further training, correctly say that bananas grow on trees. He may also conclude that since apples and peaches have seeds, bananas do also.

Sidman (1977) considered the formation of equivalence classes to be an instrumental part of reading development. For example, in one of his earlier experiments (Sidman, 1971), he directly taught a subject who could already match visual pictures to their auditory names (an A-B relation) to match printed picture names to their corresponding auditory names (an A-C relation). He found that, without training, the subject could then match the visual pictures to their corresponding printed names, and vice versa (C-B and B-C relations). The subject (who could name the pictures prior to the experiment) also was capable, for the first time, of correctly naming the printed words of the pictures (C-D relation). Sidman considered this last relation simply as "oral reading," naming the printed words (Sidman, 1971, p. 5) . This is not, however, necessarily an indication of comprehension. The accurate matching of printed words to pictures, and printed pictures to printed words, would demonstrate comprehension (the B-C, C-B relation). Sidman termed the explicitly taught relation (matching printed words to auditory stimuli, the A-C relation) "auditory-receptive reading" (p. 5).

Sidman (1971) found that by forming equivalence classes consisting of printed words, their corresponding pictures, and their corresponding auditory names, the subject showed a thorough understanding of each word. This was demonstrated with the emergence of oral reading and reading with comprehension after the explicit teaching of auditory receptive reading.

Many other researchers have demonstrated the emergence of stimulus equivalence classes in human subjects (e.g., Lazar, Davis-Lang, & Sanchez 1984; Sidman & Cresson, 1973; Sidman, Cresson, & Wilson-Morris 1974). The generative power of these class formation paradigms was, perhaps, best demonstrated by Sidman, Kirk, and Wilson-Morris (1985) when they developed three six-member stimulus classes in mentally retarded students. By explicitly teaching 15 relations, 60 new relations were generated.

Some researchers have attempted, unsuccessfully, to establish equivalence classes in nonhumans (D'Amato, Salmon, Loukas, & Tomie, 1985; Sidman et al., 1982). Yet Sidman et al. (1982) showed the development of robust equivalence classes in children using methods similar to those used unsuccessfully with monkeys. These researchers suggested that the formation of stimulus classes may be uniquely human.

McIntire, Cleary, and Thompson (1987) suggested that the difference between the capabilities of humans and nonhumans in the formation of equivalence classes may be related to verbal behavior. They taught monkeys to group six colors into sets of two by emitting a differential response topography in the presence of each set. They called this naming and reported that the monkeys were capable of forming two three-element equivalence classes with the properties of reflexivity, symmetry, and transitivity.

The topographically distinct response in the McIntire et al. (1987) study may have been the major factor in the development of equivalence classes in the monkeys. In essence, they were taught to group the stimuli because they could not do it on their own (name the stimuli). If the formation of equivalence classes is related to verbal capabilities rather than to the species of the organism, then stimulus class formation can be analyzed in terms of verbal behavior.

This research would seem relevant to humans with profound language deficits. It could be that in many cases the lack of verbal behavior rather than organic difficulties may be the inhibiting factor in the formation of equivalence classes. Spradlin et al. (1973) suggest that stimulus class formation leads to concept formation, and concept formation is a prerequisite for effective language development. Therefore failure to exhibit the transfer needed to form stimulus classes may result in a profound language deficit. This seems to be a critical aspect of mental retardation.

Normal children seem to develop equivalence classes naturally. Thus, they follow the sequence suggested by Spradlin et al. (1973); equivalence class formation leads to concept formation and concept formation leads to effective language development. Many retarded children never receive proper language training because it is assumed that there is little or nothing that can be done about their deficit. It is likely, however, that language can be taught if some of the prerequisite skills are taught. If stimulus class formation fails to develop, or develops poorly, then it may need to be artificially developed.

Given the importance of stimulus class formation, it becomes apparent that teaching methods for establishing the most effective (quickest, largest, etc.) formation of stimulus classes need to be researched. There has been a fair amount of research dedicated to the issue of training methods (e.g., Lazar et al., 1984; McIntire et al., 1987; Sidman et al., 1985; Spradlin et al., 1973). However, one possibly important area has gone relatively unnoticed; that area is the comparison of topography-based verbal behavior with selection-based verbal behavior.

As stated above, a secondary purpose of this study was to determine which of the two language systems (topography-based and selection-based) led to the quickest class formation and which system resulted in greater accuracy of responding.

CHAPTER II

METHOD

Subjects

Four subjects were selected from a group of mildly and moderately mentally retarded residents of a group home operated by Residential Opportunities Inc. (ROI) of Kalamazoo, Michigan. Their ages ranged from 33 to 50. The selection criteria were: a moderate to severe language deficit, the exhibition of manual dexterity allowing for the formation of signs, the ability to imitate, and the ability to follow instructions. Guardian and official ROI consent were obtained prior to each subject's participation in the study.

Mary was a 50-year-old moderately retarded female. She followed directions and appeared to understand what was being said, but seldom spoke out. When she did speak she emitted one or two-word sentences.

Dan was a 33-year-old moderately retarded male with Down's syndrome. Like Mary, Dan followed directions and appeared to understand what was being said, but seldom spoke and when he did so, he emitted one or two-word sentences.

Gary was a 46-year-old moderately to mildly retarded male with Down's syndrome. He had a larger verbal repertoire than Dan and Mary and he talked in more complete sentences most of the time.

Eric was a 40-year-old mildly retarded male with Down's syndrome. Eric was the highest functioning of the four subjects.

None of the subjects had any prior experience with sign language or a symbol board.

Setting

The study was conducted in a 5 m X 7 m room in the subjects, group home. This room was normally used as an office and was empty except for a desk, a bookshelf, two folding chairs, and a card table where the subject and the experimenter sat. A third chair was brought in on days when reliability data were taken.

The experimental sessions were conducted five days a week. Monday though Thursday they were at 7:00 p.m. after dinner. Friday, because of scheduled social activities, the sessions were at 4:00 p.m. Each session consisted of 60 trials and lasted approximately 20 minutes.

Apparatus\Materials

All subjects were taught relations between nonsense objects and symbols, nonsense names and symbols, nonsense objects and signs, and nonsense names and signs. Nonsense names, symbols, and signs were used to guard against the possible influence of any history the subjects may have had with any of the signs, symbols, or objects. The objects, symbols, and signs were also chosen so as to guard against differential ease of acquisition because of iconicity factors.

For three of the subjects, six objects were used. The objects were made of wood, plastic, metal, foam rubber, and cardboard. The objects were of various shapes and had no obvious function. Each object was assigned an arbitrary symbol drawn in black ink on a 4" by 4" piece of white poster board (for the selection-based paradigm). The symbols resembled a triangle, a circle, a square, a W, an X and a U.

Each object was also assigned an arbitrary sign (for the topography-based paradigm). The sign for an oblong wood object was a pat on the head. The sign for the metal piece was a pinch of the nose. The sign for the plastic piece was the open palm of the right hand striking the fist of the left hand (as in the game where "paper covers rock"). The sign for a circular piece of wood was the opening and closing of both hands two times. The sign for the foam rubber was two fists circling each other. The sign for the cylinder cardboard piece was the pointing of the right forefinger to the left palm.

Each object, sign or symbol set was assigned a nonsense name. The zug set consisted of the oblong piece of wood, the triangle symbol (when the selection-based paradigm was used), and the pat on the head for the sign (when the topography-based paradigm was used). The sigpie set consisted of the metal piece, the circle symbol, and the nose pinch for the sign. The cabbie set consisted of the plastic piece, the square symbol, and the open palm over the closed fist for the sign. The poe set consisted of the circular wood piece, the W symbol, and the opening and closing of the hands for the sign. The wiglet set consisted of the foam piece, the the X for the symbol, and the circling fists for the sign. The krepola set consisted of the cylinder cardboard piece, the U for the symbol, and the pointing of the right forefinger to the left palm for the sign.

For the fourth subject, Eric, a reversal was added because he finished far ahead of the others. In addition to the previous paradigms Eric was trained and tested with an additional selection-based paradigm. The mojam set consisted of a triangular rubber piece and an abstract line drawing. The kad set consisted of a rectangular piece of metal and a different abstract line drawing (distinguishable from the first). The bogad set consisted of a square piece of wood and a different abstract line drawing (distinguishable from the first two).

The name of each set was written on a 5 cm X 3 cm cardboard card and randomly drawn out of a bag before each trial to determine which set would be tested or trained for that particular trial.

Reinforcer Selection

Because all of the subjects were on restrictive diets, and all were appreciative of the value of money, pennies and praise were used as reinforcers. Weekly outings to a local restaurant or fast food outlet were also given to help insure that subjects remained interested in the study.

Measurement

Responses were recorded as correct or incorrect by writing the response time in one of two columns under one of three sets (see Figure 1). For example, if Gary were being trained in the selection-based tact relations, the three sets would be poe, wiglet, and krepola. If he failed to select the W symbol when shown the circular wooden piece, then his response time would be recorded in the right side of the poe column (the "wrong" side).

Subject: Dan
Date: 10-24-89
Paradigm: Selection-Based Tact

Object: Poe		Object: Wiglet		Object: Krepola	
Right	Wrong	Right	Wrong	Right	Wrong

Figure 1. Sample data sheet

The first symbol pointed to or the first sign made was the one recorded. The mastery criterion was defined as a sequence of ten responses, with nine correct.

Dependent Variable

Two relations for each paradigm were directly taught and one was tested. Relations that were explicitly taught were the tact (i.e., pointing to a symbol or making a sign when shown an object), and the intraverbal (i.e., pointing to a symbol or making a sign when an object name is spoken). Testing was done for the emergence of mand-compliance, or receptive language (i.e., pointing to the object when the object's name is mentioned).

For a response to have been recorded as correct, it must have been a close enough approximation to the desired response that it could be easily distinguishable by the experimenter from the other responses in the subject's repertoire.

The two paradigms were compared by looking at the number of testing trials before the subject met criterion for the mand compliance relation. The number of training trials until the tact and intraverbal relations were mastered was also examined. In addition, percent correct and latency of responding (until mastery criterion was met) during test and training trials were analyzed.

During the testing sessions (after the tact and intraverbal relations were mastered), unreinforced mand-compliance probe trials occurred once in every three trials. These probe trials were intermixed with tact and intraverbal trials. Subjects were told at the beginning of each test session that they would not be given feedback for the mand-compliance probes. Each subject was told: "When I ask you to point to one of these objects, I'm not going to tell you if you are right or wrong but when we are all finished I will give you a penny for each one you got right."

Response Definitions

Topography-Based Tact

When shown a certain object and asked "What's this?", the subject makes the correct sign within ten seconds of its presentation (e.g., when shown the oblong wood piece and asked "What's this?" the subject pats his head with his right hand within ten seconds).

Topography-Based Intraverbal

When the vocal name of an object is spoken by the experimenter, the subject makes the correct sign within ten seconds of its presentation (e.g., when the experimenter says "What's zug?" the subject pats his head with his right hand within ten seconds).

Selection-Based Tact

When shown a certain object and asked "What's this?", the subject points to the correct symbol (out of an array of three) within ten seconds of its presentation (e.g., when shown the oblong wood piece and asked "What's this?" the subject points to the triangle symbol within ten seconds). The first symbol pointed to is recorded.

Selection-Based Intraverbal

When the vocal name of an object is spoken by the experimenter, the subject points to the corresponding symbol (out of an array of three) within ten seconds of its presentation (e.g., when the experimenter says "What's zug?" the subject points to the triangle symbol within ten seconds).

Mand-Compliance/Test for Transfer

When asked to pick out an object, the subject correctly picks out the object within ten seconds of the request (e.g., when asked "Which one's zug?" the subject points to the oblong wood piece within ten seconds).

Data Collection and Reliability Checks

Each trial was recorded as correct or incorrect. Percentage of correct responses was calculated for each session for each of the relations studied, for both paradigms (see line graphs). The average percentage of correct responses for each relation under each paradigm was also calculated (see bar graphs). In addition, the number of trials needed to reach the nine out of ten criteria was also recorded (see bar graphs).

Reliability data on subjects' responses were collected by a trained observer who was a graduate student in psychology at Western Michigan (Kalamazoo) University. The observer used the same type of data sheet as the experimenter and was seated at a nearby desk so that she could see the subject's responses but not the experimenter's data. Reliability was calculated for each observed session using the following formula: [TRIALS SCORED IN AGREEMENT DIVIDED BY (TRIALS SCORED IN AGREEMENT + TRIALS SCORED IN DISAGREEMENT)] X 100. For a trial to be recorded as an agreement the observer and trainer must have both agreed on a recorded response as correct or incorrect under one of the three sets (e.g., "zug," "sigpie," or "cabbie"). Reliability data were taken for six sessions for Dan (208 trials), eight sessions for Mary (366 trials), four sessions for Gary (199 trials), and four sessions for Eric (164 trials). Inter-observer agreement per subject ranged between 91 and 96 % (see Table 1).

Table 1

Interobserver Agreement

SUBJECT	TRIALS	AGREEMENT	PERCENTAGE
Dan	208	199	96
Gary	199	188	94
Eric	164	149	91
Mary	366	353	96

Procedure

General

The general procedure consistcd of (a) the training of the topography-based and selection-based tacts and intraverbals; and (b) a series of probe trials to test for transfer effects.

Pretraining

Pretraining for the topography-based tact consisted of the experimenter holding up an object and making the corresponding sign and saying, "This (holding up the object) equals this" (making the sign). The subjects were then asked to imitate the sign. All subjects demonstrated imitation on the first pretraining trial.

This procedure was then repeated for the other two objects. The three sign to object relations were demonstrated approximately five times each at the beginning of each new phase, and repeated only twice at the start of each session.

Pretraining for the topography-based intraverbal consisted of the experimenter saying the name that relates to a sign and object, and making the corresponding sign. After this point the same process as with the tact was followed.

Pretraining for the selection-based tact consisted of the experimenter holding up an object and pointing to the corresponding symbol out of an array of three and saying "This (holding up the object) equals this" (pointing to the corresponding sign). After this was done the same process as with the other relations was followed.

Pretraining for the selection-based intraverbal consisted of the experimenter saying the name that relates to a sign and an object, and pointing to the corresponding symbol. After this was done the same process as with the other relations was followed.

Training Verbal Relations

Each subjec was taught two-thirds of three stimulus set relations for one paradigm (e.g., topography-based tacts and intraverbals). The subjects were then tested for the emergence of mand-compliance (the untrained relation). The subjects were then taught two-thirds of three stimulus set relations for the other paradigm (e.g., selection-based tacts and intraverbals). For example, Gary was taught the oblong piece of wood, pat on the head, zug stimulus set; the metal piece, pinch of the nose, sigpie stimulus set; and the plastic piece, palm covering fist, cabbie stimulus set for the topography-based stimulus set. He was then tested for transfer. For the selection-based paradigm he was taught the circular wood piece, M symbol, poe stimulus set; the foam rubber piece, X symbol, wiglet timulus set; and the cylinder cardboard piece, U symbol, and krepola stimulus set. He was then tested (see Table 2).

Mary was taught the same relations in the same order as Gary. Dan and Eric were trained and tested using the selection-based paradigm first and then the topography-based paradigm. Since Eric was the first subject finished he was trained and tested using another selection-based paradigm with three new symbols, objects, and names.

Topography-Based Tact Training

After a brief pre-training session (five demonstrations for each set), topography-based tact training began and

Table 2

The Verbal Relations

Topography-based	Selection-based
Oblong Wood Piece, Pat on Head, Zug	Oblong Wood Piece, Triangle Symbol, Zug
Metal Piece, Nose pinch, Sigpie	Metal Piece, Circle Symbol, Sigpie
Plastic Piece, Palm Covering Hand, Cabbie	Plastic Piece, Square Symbol, Cabbie
Circular Wood Piece Open/Close Hands, Poe	Circular Wood piece, W Symbol, Poe
Foam Rubber Piece, Circling Fists, Wiglet	Foam Rubber Piece, X Symbol, Wiglet
Cylinder Cardboard Piece, Finger to Palm, Krepola	Cylinder Cardboard Piece, U Symbol, Krepola

data collection was started. Training began with the experimenter drawing a name out of a bag and holding up the corresponding object and saying "What is this?" If the subject emitted the correct sign, s/he would be given verbal praise and a penny. If the subject did not make a sign, the proper sign would be demonstrated along with the verbal prompt: "This (pointing to the object), is this" (making the sign). If the subject made the wrong sign, s/he would be informed of the error while being shown the object that goes with the sign that was emitted. This was followed by a demonstration of the correct sign along with the verbal prompt. This sequence was repeated 60 times (ending the session for that day) or until the criterion was met.

When the criterion (nine out of ten correct for all three relations) was met, the subject moved on to the next phase. The order of phases were: tact-intraverbal-test (with one paradigm); tact-intraverbal-test (with the other paradigm). For all the verbal relations, a brief remedial pretraining period took place at the beginning of each session (two demonstrations for each set).

Topography-Based Intraverbal Training

After the pretraining session, topography-based intraverbal training began with the experimenter drawing a name out of a hat and asking the subject to make the corresponding sign (e.g., "Sign zug"). Correct responses were treated the same as with the tact. If no response was made, the experimenter would say: "This (while making the sign) is____" (saying the name). If the wrong response was made, the experimenter would correct the subject by telling him or her the name of the sign that was just made followed by a demonstration of the correct sign accompanied by the name of the sign (e.g., "No that was sigpie, this is zug"). This sequence was repeated 60 times or until the criterion was met.

Topography-Based Test for Transfer

When the mastery criterion was met for the intraverbal relation, testing for the emergence of mand-compliance (the untrained relation) was begun. An unreinforced mand-compliance probe occurred after every two consecutive baseline trials. A baseline trial consisted of randomly choosing a tact or intraverbal relation, and proceeding with the same operation as described for the training. For the probe trial, the experimenter would simply point to the three objects and ask the subject to point to the one which was randomly requested. For example, the experimenter might point to the objects (calling attention to them) and say "Which one is <u>cabbie</u>?" The subject only learned to make the corresponding sign in the presence of the plastic piece and to make the same corresponding sign when asked to sign cabbie. Asking to identify which object is cabbie was a new relation and making this identification nine out of ten times for all three sets would demonstrate partial equivalence.

Selection-Based Tact Training

After the brief pretraining session, selection-based training began with the experimenter drawing a name out of a bag, holding up the corresponding object and saying

"What is this?" If the subject pointed to the correct symbol, s/he would be given verbal praise and a penny. If the subject did not point to a symbol, the experimenter would point to the correct symbol while giving the verbal prompt "This (holding up the object) is this" (pointing to the correct symbol). If the subject pointed to the wrong symbol, s/he would be informed of the error while being shown the object that corresponds to the symbol s/he selected. This was followed with a demonstration in which the experimenter would hold up the original object and point to the correct sign along with a verbal prompt. This sequence was repeated 60 times or until the criterion was met.

Selection-Based Intraverbal Training

After the pretraining session, selection-based intraverbal training began with the experimenter drawing a name out of a hat and asking the subject to point to the corresponding symbol (e.g., "Which one is zug?"). Correct responses were treated the same as the other relations. If no response was made, the experimenter would say: "This (while pointing to the symbol) is____" (saying the name). If the subject pointed to the wrong symbol the experimenter would correct the subject by telling him or her the name of the symbol, that was selected followed by a demonstration of the correct symbol accompanied by the name of the symbol (e.g., "No that was <u>poe</u>, this is <u>wiglet</u>").

<u>Selection-Based Test for Transfer</u>

The selection-based test for transfer was identical to the topography-based test for transfer.

CHAPTER III

RESULTS

The data indicate that a significant difference existed between the two language systems with regard to the ease of tact acquisition, intraverbal acquisition, and the formation of equivalent stimulus classes. Three of the four subjects demonstrated faster acquisition of every relation when they were trained with the topography-based paradigm. The fourth subject performed equally well with both paradigms, perhaps suggesting that he was too high functioning for the level of this experiment. Percent of correct responses were also significantly higher during the topography-based paradigm, especially with regard to the tact and the test for equivalence.

A serendipitous finding was that the tact was acquired faster than the intraverbal for the three subjects with the weaker verbal skills. This was true for both paradigms. One subject never reached criterion for the selection-based tact, however, and was not trained on the selection-based intraverbal relation (see Tables 3 and 4).

Gary was first trained and tested using the topography-based paradigm. He was then trained and

Table 3

Tacts Compared to Intraverbals:
Trials to Criterion

	SB TACT	SB IV	TB TACT	TB IV
Mary	841	---	163	304
Dan	234	426	37	388
Gary	34	120	28	37
Eric	60 (1st)	34 (1st)	31	29
	37 (2nd)	28 (2nd)		

Table 4

Tacts Compared to Intraverbals:
Percent Correct

	SB TACT	SB IV	TB TACT	TB IV
Mary	28	---	48	53
Dan	55	46	86	43
Gary	82	62	96	76
Eric	72 (1st)	88 (1st)	90	93
	86 (2nd)	96 (2nd)		

tested using the selection-based paradigm. Figures 2-7 show that he reached criterion for the topography-based tact, intraverbal, and test significantly faster than with the selection-based paradigm. Furthermore, his percentage of correct responses was also significantly higher with the topography-based system.

Figure 8 is a complete summary of Gary's performance throughout the experiment. Sessions that have one data point represent training sessions. Sessions that have two data points (e.g., circles directly underneath boxes) represent testing sessions. The lower data points represent the probe trials (i.e., tests for mand-compliance); the upper data points represent the baseline trials (i.e., tacts and intraverbals intermixed with the probe trials).

As can be seen in Figure 8 (from left to right and with conditions on right margin from bottom to top), Gary quickly learned the topography-based tact and intraverbal relations (one session each), and eventually reached criterion for the topography-based test (mand compliance) bringing his percentage of correct responses close to that of the baseline trials.. The selection-based tacts, and intraverbals took slightly longer (four sessions total). The boxes representing the selection-based test show that Gary never reached criterion, even after twice as many sessions as the topography-based paradigm.

Furthermore, there was only a slight upward trend suggesting that it may have taken many more sessions for criterion to be reached. This graph also shows that the percentage of correct responses for the selection-based baseline trials was significantly lower than for the topography-based trials.

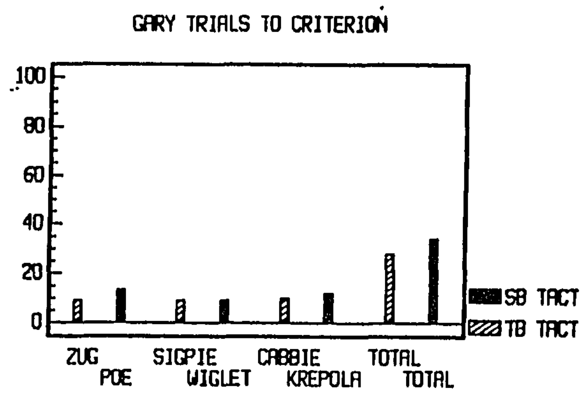

Figure 2. Trials Needed for Gary to Reach Criterion for The Tacts.

Dan was first trained and tested using the selection-based paradigm. He was then trained and tested using the topography-based paradigm. As can be seen in Figures 9-14 he performed significantly better with the topography-based tact, and test. The difference was minimal for the intraverbal.

After 183 selection-based test trials, Dan had demonstrated only partial stimulus equivalency by meeting criterion for one of the three sets only. At this point, it appeared that there was no upward trend in the

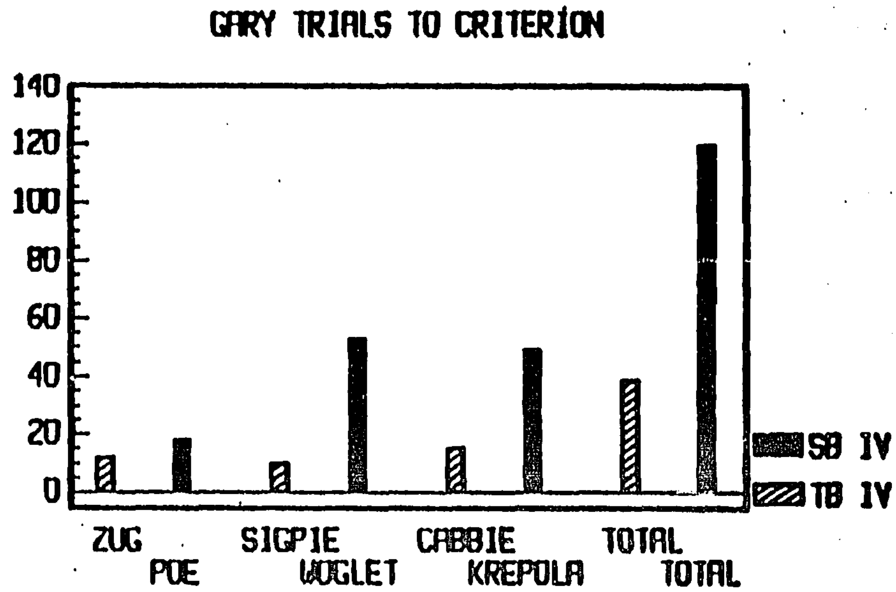

Figure 3. Trials Needed for Gary to Reach Criterion for the Intraverbals.

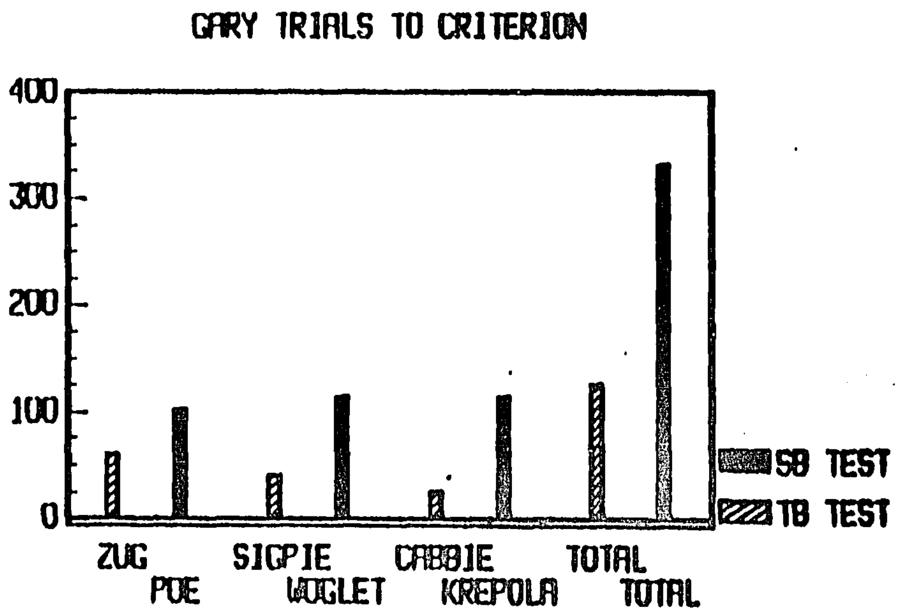

Figure 4. Trials Needed for Gary to Reach Criterion for the Tests.

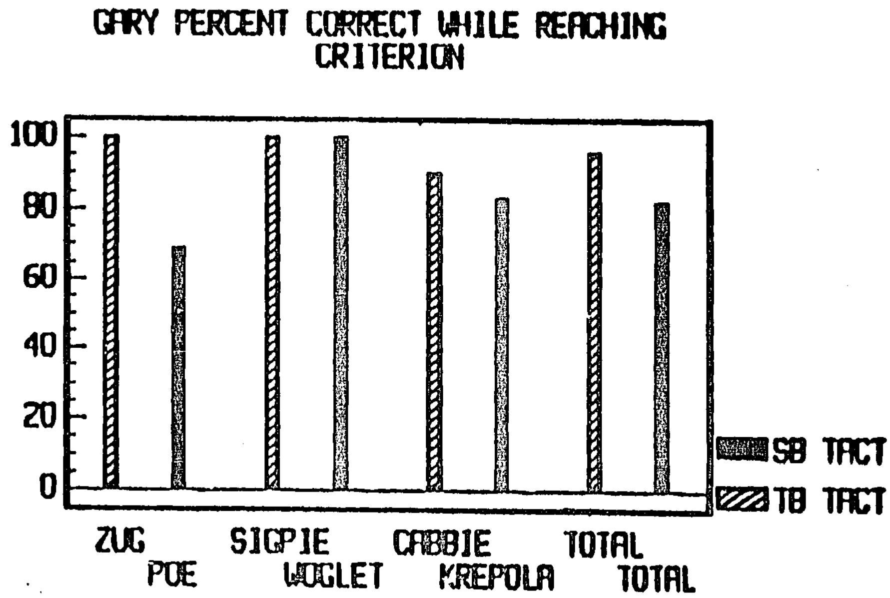

Figure 5. Gary's Percentage of Correct Responding for the Tacts.

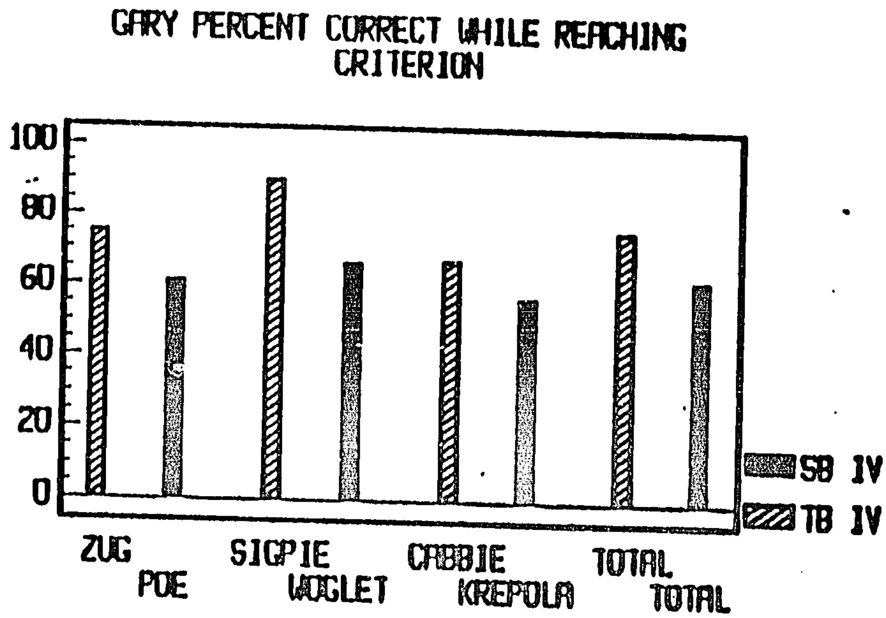

Figure 6. Gary's Percentage of Correct Responding for the intraverbals.

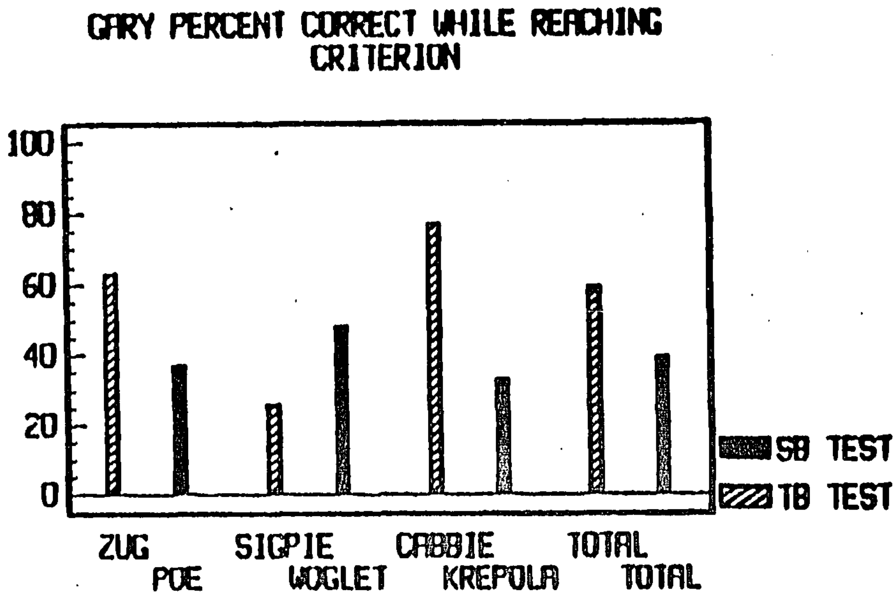

Figure 7. Gary's Percentage of Correct Responding for the Test.

percentage of correct responding and that he was not going to demonstrate class formation soon. Because of the time restraints, a phase shift was employed at that time.

Dan was then trained and tested using the topography-based paradigm. Although he did not reach testing criterion for this paradigm either, Figure 14 shows that his percentage of correct responses was significantly higher, as was his topography-based baseline performance. (Compare the double data points on the right {circles over squares} with the double data points on the left {squares over circles}.)

Data on trials to criterion for the testing phase

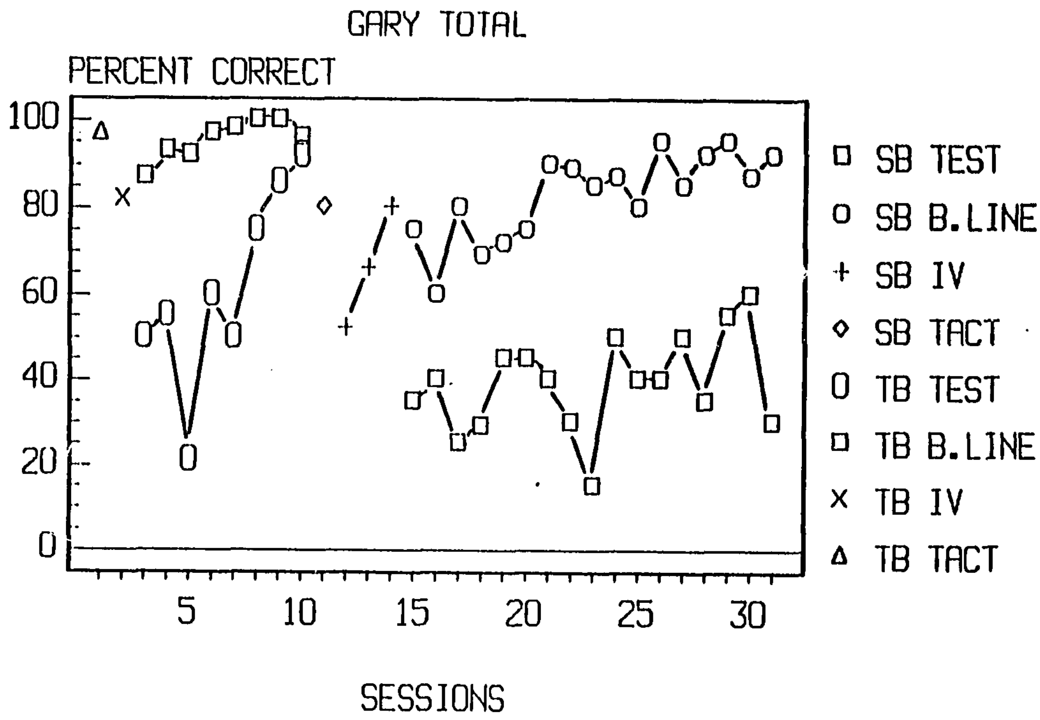

Figure 8. Summary of Gary's Percentage of Correct Responding for each session.

are not included since Dan did not meet criterion with either model. Testing phases (for Dan) for both paradigms were stopped after 10 sessions.

Mary was first trained and tested using the topography-based paradigm, where she met criterion for the tact, intraverbal, and the test for stimulus equivalency. She was then trained and tested using the selection-based paradigm. Figures 15 and 16 show that she performed significantly better on the topography-based tact, than the selection-based tact. As can be seen in Figure 17, however, this was the only comparison

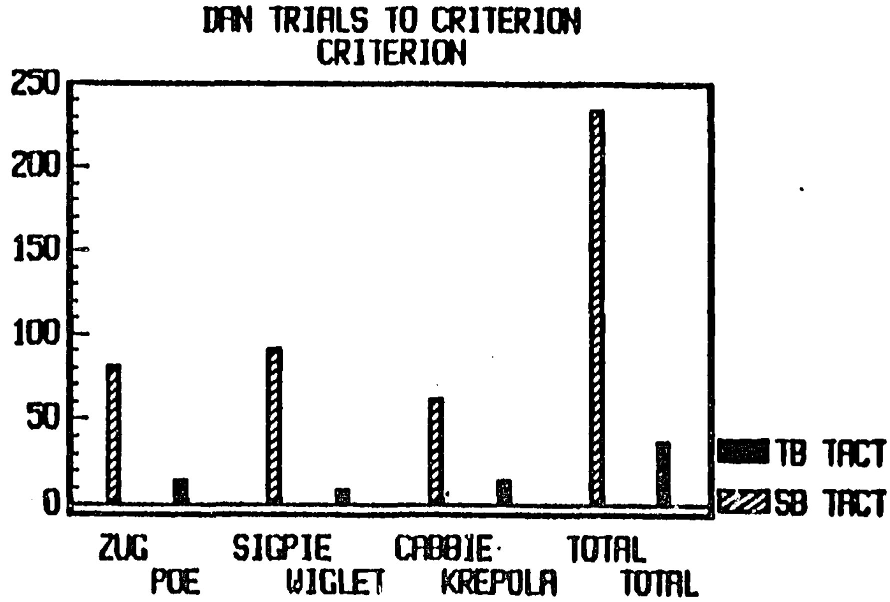

Figure 9. Trials Needed for Dan to Reach Criterion for the Tacts.

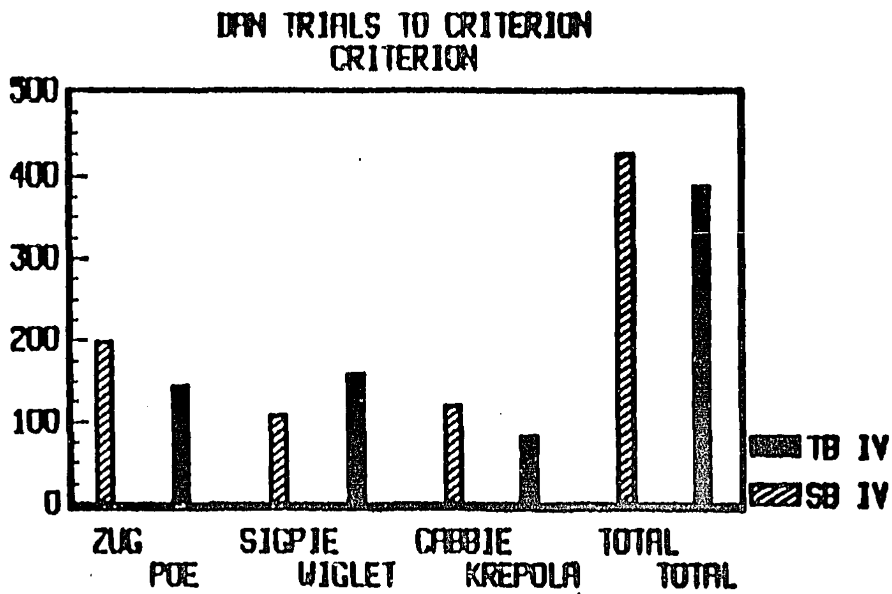

Figure 10. Trials Needed for Dan to Reach Criterion for the Intraverbals.

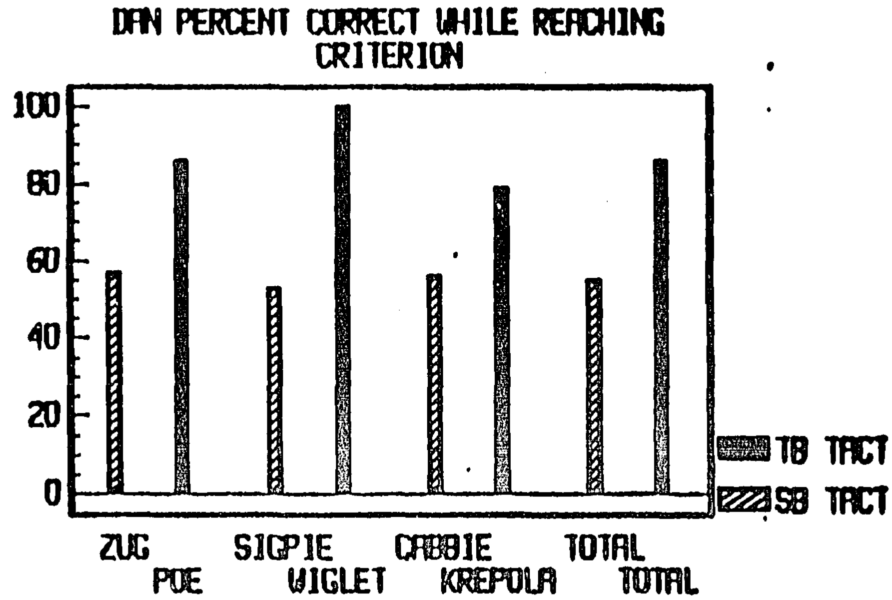

Figure 11. Dan's Percentage of Correct Responding for the Tacts.

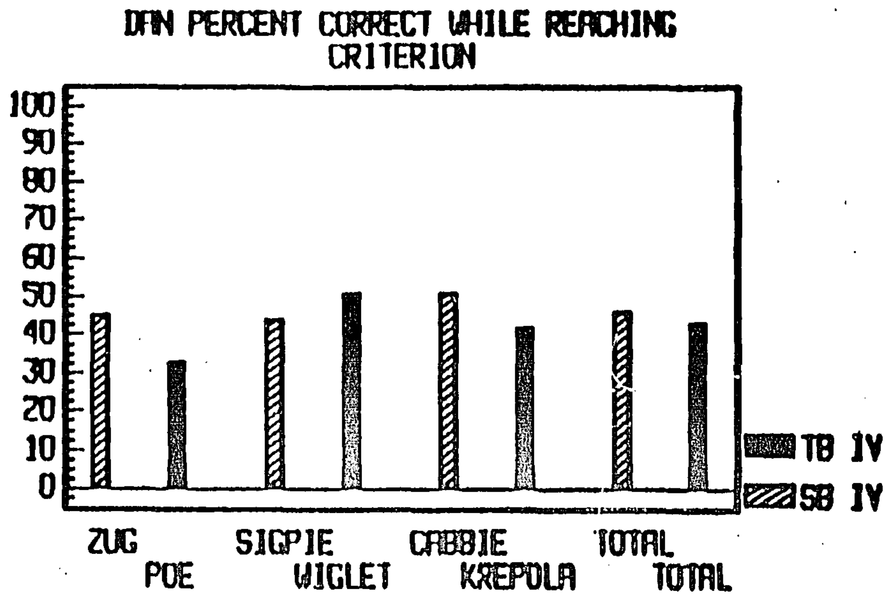

Figure 12. Dan's Percentage of Correct Responding for the Intraverbals.

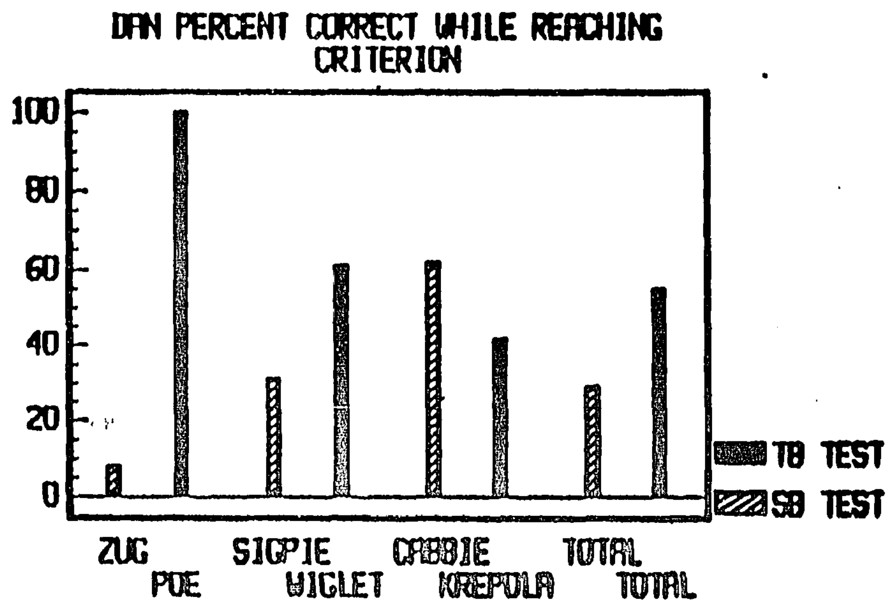

Figure 13. Dan's Percentage of Correct Responding, for the Tests.

that could be made because she never met criterion for the selection-based tact. Mary performed so poorly on the selection-based tact that her percentage of correct responses was at chance level (33.3 percent).

Eric was first trained and tested using the selection-based paradigm. He was then trained and tested with the topography-based paradigm. A reversal back to the selection-based paradigm was then done because Eric was the first subject finished and a sequence effect was suspected.

Figures 18-24 show that, for the tact and intraverbal, there was not much difference between the two paradigms after the tact training for the selection-based paradigm (the first phase of the experiment). Eric

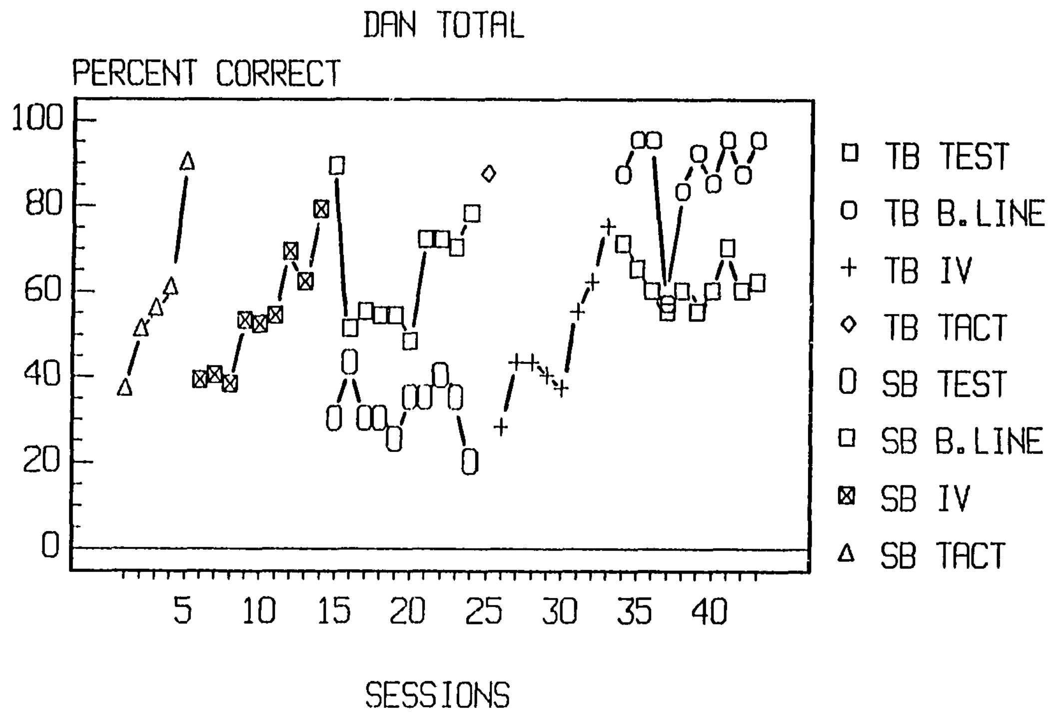

Figure 14. Summary of Dan's Percentage of Correct Responding for each Session.

met criterion for the first selection-based test in 112 trials. Test criterion was met after 116 trials for the topography-based paradigm, but during testing Eric immediately confused two objects and consistently picked the Krepola object when asked to identify poe, and he consistently picked the poe object when asked to identify krepola. He correctly identified wiglet in 100 percent of the trials. Even though his reversal of objects inflated his testing data, it was apparent by his training trials, his 100% correct responding to wiglet, and the invariable reversal of objects that he was

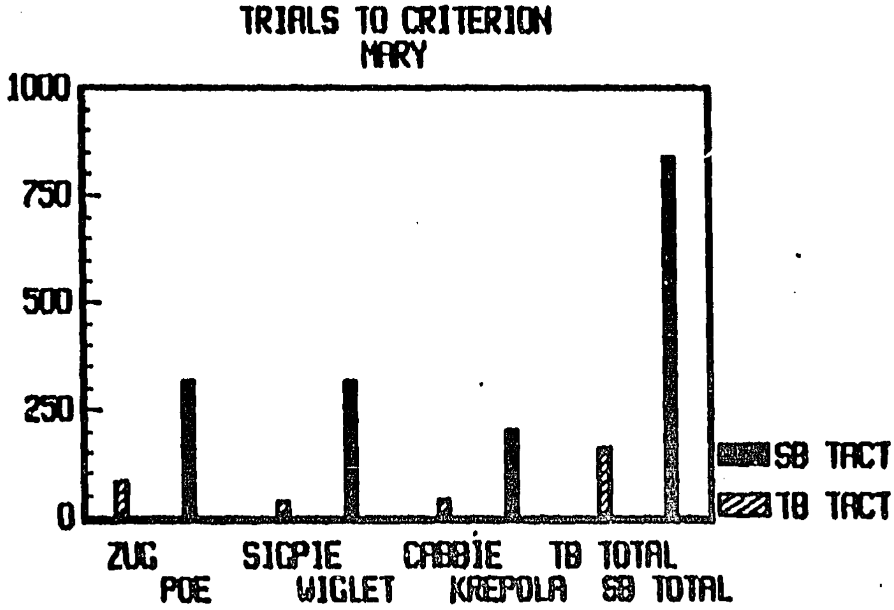

Figure 15. Trials Needed for Mary to Reach Criterion for the Tact.

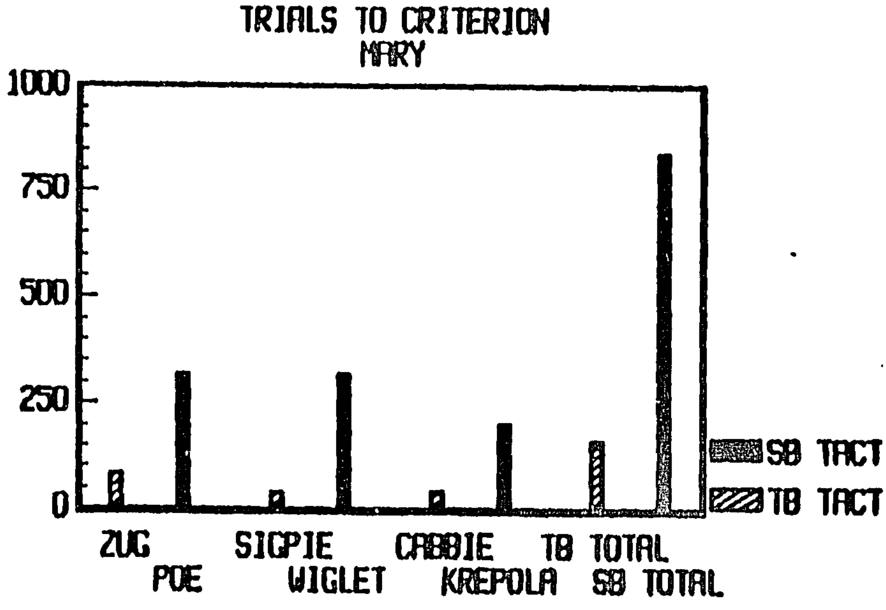

Figure 16. Mary's Percentage of Correct Responding for the Tacts.

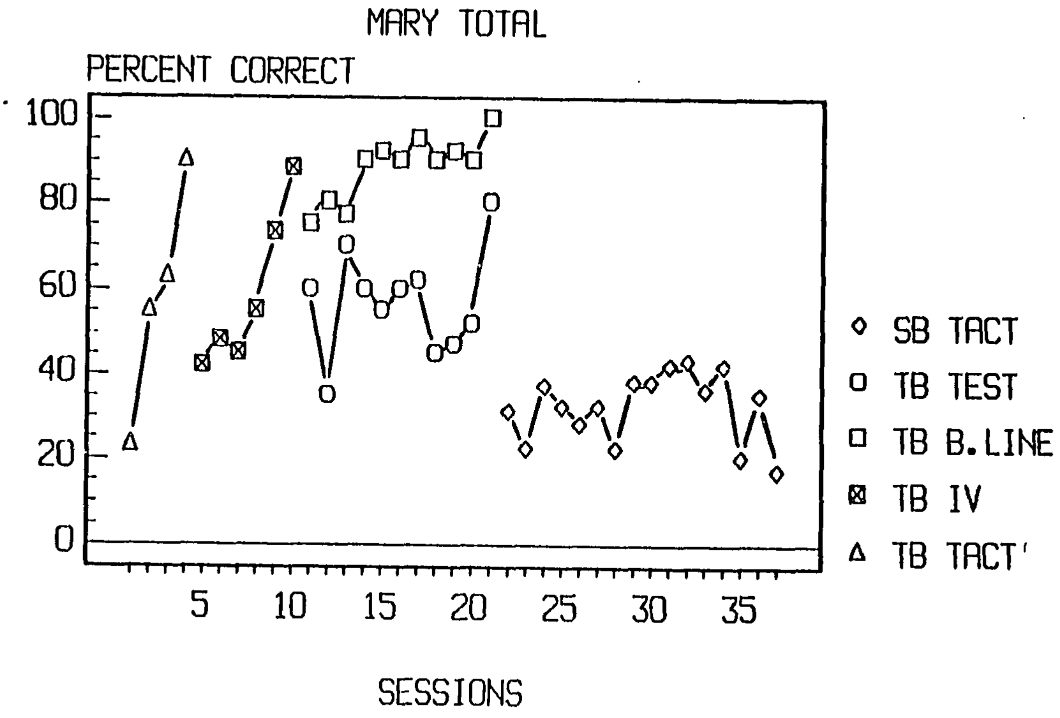

Figure 17. Summary of Mary's Percentage of Correct Responding for each Session.

performing better on the topography-based paradigm than on the first selection-based paradigm. His almost perfect performance on the second selection-based paradigm, however, confirmed the suspicions of a sequence effect.

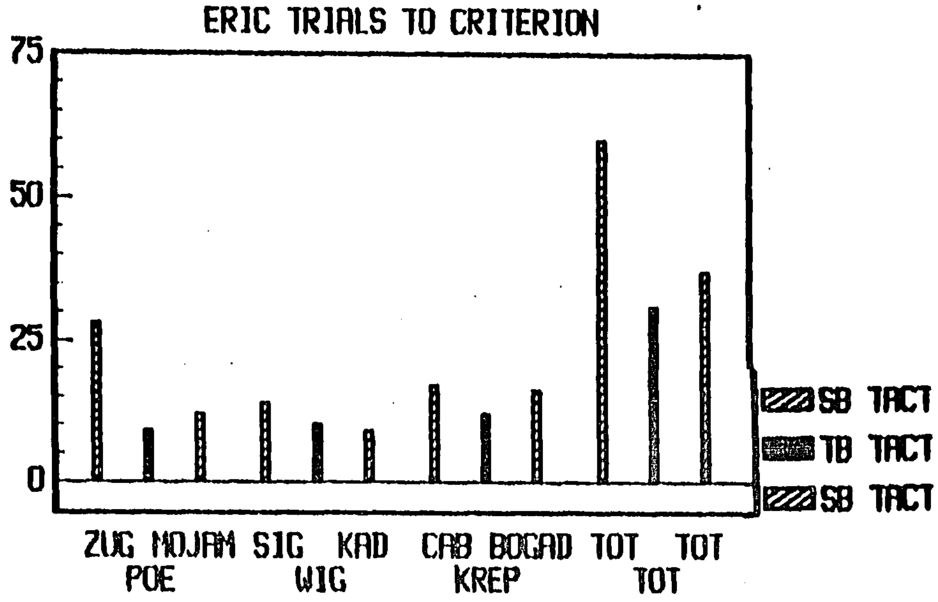

Figure 18. Trials Needed for Eric to Reach Criterion for the Tacts.

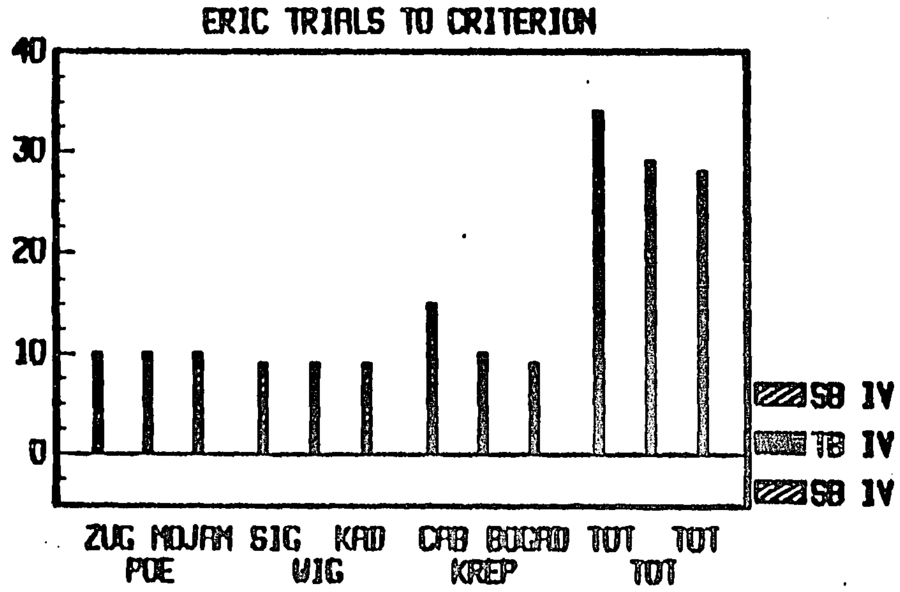

Figure 19. Trials Needed for Eric to Reach Criterion for the Intraverbals.

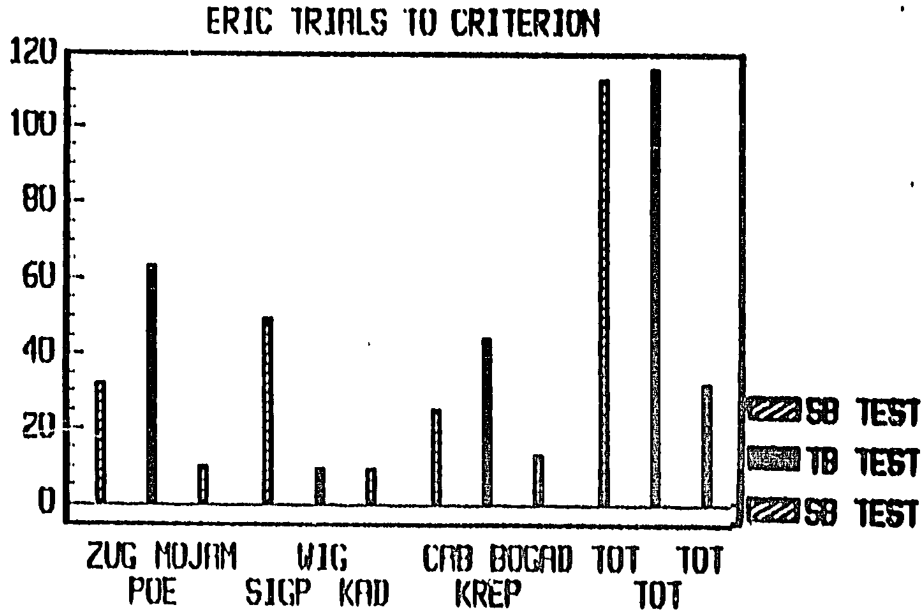

Figure 20. Trials Needed for Eric to Reach Criterion for the Tests.

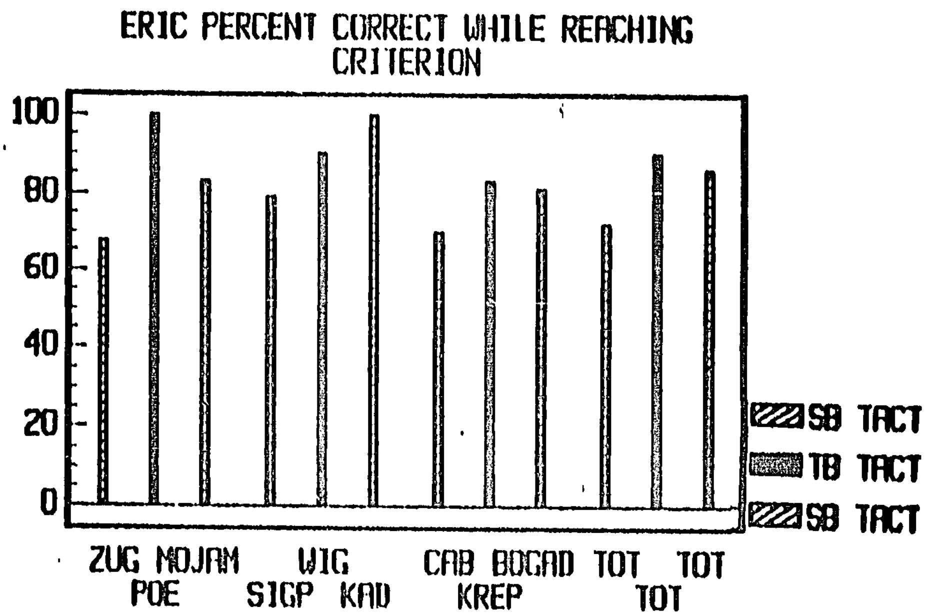

Figure 21. Eric's Percentage of Correct Responding for the Tacts.

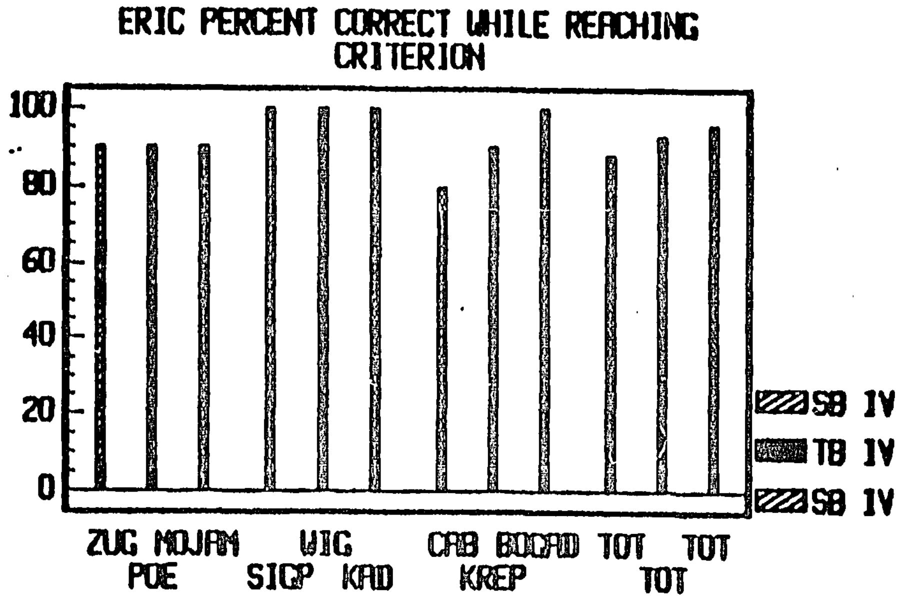

Figure 22. Eric's Percentage of Correct Responding for the Intraverbals.

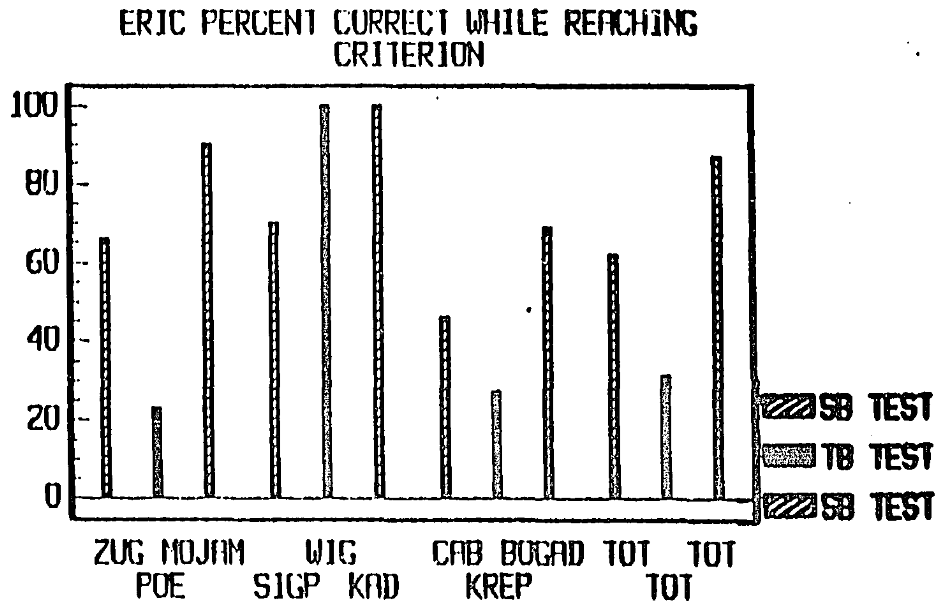

Figure 23. Eric's Percentage of Correct Responding for the Tests.

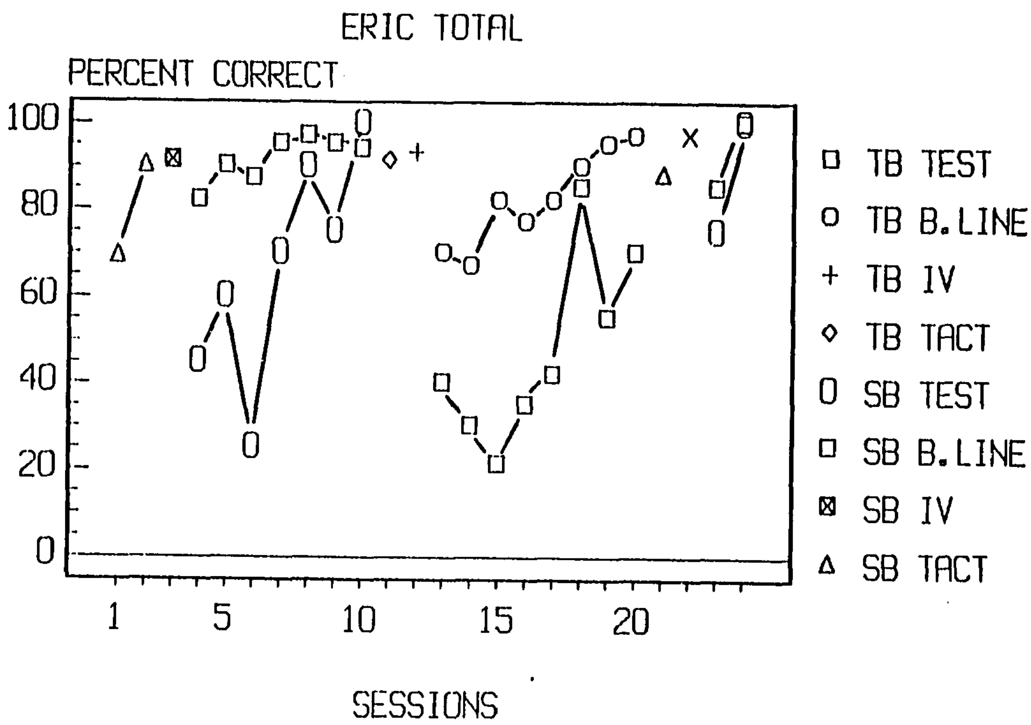

Figure 24. Summary of Eric's Percentage of Correct Responding for each Session.

CHAPTER IV

DISCUSSION

This study was designed to assess the differences between selection-based and topography-based verbal behavior. Two questions were asked: (1) Which paradigm would lend itself to better (faster and more accurate) tact and intraverbal acquisition and, (2) which paradigm would lead to faster development of equivalence classes? In other words, are tact and intraverbal repertoires acquired easier with sign language, or with a symbol language? Is stimulus equivalency more likely to form with sign language, or with a symbol language? Two of the subjects (Dan and Mary), however, had difficulty learning the selection-based relations and one subject (Eric) performed swiftly on both paradigms. Assuming that the stimuli involved in the study were too simple to test Eric accurately because of his higher functioning level, his results do not add significantly to this study. As a result, only Gary demonstrated class formation with one paradigm (topography-based) and not the other (selection-based). Dan demonstrated a significantly higher percentage of correct responses during testing with the topography-based paradigm but did not reach criterion for either. Mary demonstrated class formation with the topography-based paradigm but never reached criterion for the selection-based tact; therefore the intraverbal could not be trained and the test could not be done.

With regard to the stimulus equivalency question, only Gary's data can be used for the interpretation of both measures (percent correct and trials to criterion), and Dan's data can be used for interpretation of one question (percent correct). These data do, however, seem to be robust and there were no data to suggest the contrary.

What was interesting and somewhat surprising was the extent to which the subjects' overall performance was better with the topography-based paradigm. Mary, for example, reached topography-based tact criterion in 163 trials. After 841 trials with the selection-based paradigm, she was not showing any signs of reaching criterion and the experiment was terminated because of time restrictions (see Figure 15). Mary also responded correctly on 48% of the topography-based tact trials for which criterion had not yet been met. She responded correctly on only 28% of the selection-based tact trials.

It took Dan 234 trials at 55% correct to meet the selection-based tact criterion, but he reached the topography-based tact criterion in 37 trials at 86% correct. There was less of a difference with the intraverbal relation (see Tables 3 and 4).

Eric was the only subject who seemed to show an obvious sequence effect. After the first couple of selection-based tact training sessions, he performed at over 90% correct for all other training relations. It was believed that because of the simple stimuli involved, Eric performed equally well on both paradigms once he understood some of the general rules. In retrospect, however, it may have been a mistake not to do a second reversal back to the topography-based paradigm. This might have made the case for a sequence effect quite conclusive since the results of the first topography-based phase were ambiguous because of the reversal of the objects.

One might question the effects of sequencing on the other subjects. Dan, for instance, was trained and tested with the selection-based paradigm first. Perhaps that could have affected his performance on the second paradigm. This seems unlikely, however, because of the abrupt change in performance from the selection-based test to the topography-based tact. Figure 14 shows that Dan performed almost perfectly and did indeed meet criterion during the first topography-based tact session. His percentage was higher than 9 out of 10 of the selection-based baseline trials immediately preceding. These baseline trials consisted of tact and intraverbal trials differing from the topography-based tact only in that they involved the selection-based system rather than the topography-based system. Also, with regard to the testing results, there is no apparent trend in performance with either of the paradigms.

Mary and Gary were trained and tested with the topography-based paradigm first. If a sequence effect was present, one would expect them to perform better on the selection-based trials and tests. This was obviously not the case. Also all subjects except for Eric performed significantly better on tact trials than they did with intraverbal trials yet all tact trials preceded all intraverbal trials.

It should also be noted that three of the four subjects were always willing to participate. They were eagerly waiting for their turn in the next room, even though all subjects were told they could wait upstairs until it was their turn to participate. These three subjects never indicated that they would like a session to be terminated, and generally seemed to enjoy the whole process.

Dan, on the other hand, did not greet the experimenter with excitement during the first half of the study (the selection-based paradigm). He would wait in his room and would have to be prompted many times. He would show signs of frustration as a session would progress and he was rarely observed smiling. In general, he was behaving as if the sessions were an aversive task. This in itself was not out of the ordinary. According to the staff, it was a chore to get Dan to participate in everyday programming (e.g., educational activities). What was noteworthy was his apparent reversal of motivation when the topography-based paradigm started. One prompt was all that was needed for Dan to proceed to the experimental room. He was observed smiling many times throughout each session and he never indicated that he did not want to participate further. In general, he was behaving as if the sessions were a game. This observation was made on a casual basis and should be cautiously interpreted.

The importance of responding to a stimulus as a mediating factor in the development of stimulus equivalent classes has been a debated topic. Sidman et al. (1974) questioned whether mediated transfer requires a response as the mediator or whether stimulus mediation was sufficient. They demonstrated that oral naming was not a necessary component in the emergence of visual auditory matching.

The results of this study also support the original conclusion of Sidman et al. (1974). It was noted, however, that some of the subjects did respond to a testing stimulus, during the topography-based phase by naming it or making the sign before they chose one of the three objects. These subjects seemed to perform better during the testing when the mediating response was made. For example, during testing Mary would be asked to point to an object (e.g., "Which one is zug?"). She would then vocally repeat the name and make the sign. As a result, she was correct on 56% of her testing trials. Gary on the other hand made no overt mediating response at all. He was correct on 59% of his topography-based test trials. This is only a difference of 3%, yet for the topography-based tact Gary was correct 96% of the trials while Mary was correct 48% of the trials, a difference of 48%. For the topography-based intraverbal Gary was correct 76% of the time while Mary was correct 53% of the time, a difference of 23%. Gary's obvious superior performance with the tact and intraverbal relations would lead one to believe that his test percentages would similarly be significantly higher than Mary's test percentages. This was not the case, however.

Dan made no mediating response during the selection-based testing. He was not very vocal and not likely to imitate, and since the symbols were temporarily removed, he could not select one. During the topography-based testing, Dan was asked to point to an object (e.g., "which one is <u>poe</u>") and he would make the sign for that object followed by his selection of the object. As a result Dan was correct on 55% of the topography-based test trials (in which a mediating response was made) and 29% of the selection-based test trials (in which no mediating response was made).

Although it was not recorded (mistakenly so), most of the test trials that Dan missed involved an incorrect mediating response. For example, if the experimenter said "which one is <u>poe</u>," and Dan made the sign for krepola, he would pick out the krepola object. This corresponded with Dan's strong performance with the topography-based tact, and his much weaker performance with the topography-based intraverbal. These data suggest that Dan formed a stronger symmetry relation with the tact than with the intraverbal.

The term <u>stimulus equivalency</u> has been used throughout this manuscript although a technically complete demonstration was not shown. There was no test for reflexivity or symmetry. According to definition, what was done was testing for transitivity. This is probably not a major issue, however, since a comparison between two systems was made, and the question was which is better. It has already been demonstrated that complete stimulus equivalency can be shown with either language system and for the purpose of this study it was not necessary to complete the whole process.

An interesting follow-up study might include a replication with higher functioning subjects, but with more complex stimuli (e.g., three component signs, and symbols, more signs and symbols to choose from, etc.). This might help determine if there is a point at which the system doesn't matter. For example, Eric seemed to be skilled enough that he mastered both systems with the same proficiency or ease. These were simple systems, however. If they had been more complex, as he might find in a functional language (e.g., putting words together into a sentence, or sequencing symbols to convey a message), perhaps he would have had more trouble with the selection-based system.

If this were the case, then perhaps a solid argument could be made in favor of sign language over the use of symbol boards (assuming the requisite motor skills). The proponents of the symbol board argue that it is inconvenient for the listener who is not adept in sign language, but it is probably more inconvenient for the speaker to be dependent on an auxiliary piece of equipment that limits the potential for communication to the symbols that are on the board. It seems that it would be quite beneficial, and worth the effort, for a client to be paired with staff that know sign language.

If a significantly larger vocabulary can be built using sign language, then more verbal interaction with the environment is likely. This, of course, leads to yet stronger verbal skills (practice). A client using a symbol board is unlikely to come in contact with many high density verbal interactions, especially if his or her vocabulary is lacking considerably.

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