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USE OF SIGNING IN DELAYED MATCHING-TO-SAMPLE WITH LANGUAGE DEFICIENT CHILDREN

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Dissertation presented to the School of Graduate Studies in partial fulfillment of the doctoral degree (Clinical Psychology) at the University of Ottawa, Ottawa, Canada.

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Abstract

Studies have demonstrated that instructing verbal production deficient individuals to use a verbal mediation strategy facilitates performance in delay tasks. In light of recent research showing sign language to be functionally similar to verbal language the present thesis intended to: (a) assess whether or not some nonverbal individuals trained in sign language could be described as sign production deficient and, (b) evaluate whether or not training sign production deficient individuals a sign mediation strategy (i.e., signing in response to a stimulus) would result in improved performance in a delayed matching-to-sample task. Four autistic children (age 11 to 16 years) trained in the use of sign language performed a number of matching tasks under two sensory modalities (visual and auditory). Three children demonstrated a sign production deficiency for visual stimuli (Experiment 1) and two children demonstrated a sign production deficiency for auditory stimuli (Experiment 2). An A-B-A design was used to evaluate the effectiveness of the sign mediation strategy. Delayed matching performance was compared under two conditions, a baseline condition with no signing of the sample and a treatment condition with signing required. In all cases and regardless of the sensory

modality, signing the sample stimulus resulted in improved delayed matching accuracy for the sign production deficient children. The findings demonstrate the effectiveness of the strategy for some nonverbal children. Implications for education and future research are discussed.

Use of Signing in Delayed Matching-to-Sample with Language Deficient Children

Literature Review

In 1913 John B. Watson published a paper on the inadequacies of psychology at the time and which was to serve as the blueprint for a new psychology. At the turn of the twentieth century two systems of thought dominated North American psychology: structuralism and functionalism (Wertheimer, 1970). Structuralism viewed the goal of psychology as the understanding of the elements of the mind. That is, sensation, images and affections (Titchener, 1910). Functionalism concurred with structuralism that the focus of study was the mind but added a more dynamic approach. The mind was viewed as an adaptive process and a function of the physical environment (Angell, 1904). For both structuralism and functionalism the method for obtaining knowledge about the mind was introspection.

Watson (1913) vehemently attacked the two fundamental tenets shared by structuralism and functionalism: the mind or consciousness as the object of study and introspection as the method of study. He urged that all reference to consciousness, unless it could be defined in terms of publicly observable behavior, be discarded. Behavior, Watson proposed, was the proper

object of study and observation of publicly observable events was the method of study. Watson was proposing an objective psychology free from all concepts that were not open to public observation. Perceptions, emotions and thoughts were rejected because their private nature served only to promote speculation and vague theories.

The goal of psychology, as envisioned by Watson (1913), was the prediction and control of behavior. Watson argued that this goal could be achieved by viewing behavior in terms of a response (R) to an environmental stimulus (S). The stimulus and the response were publicly observable events and the analysis of the conditions under which a stimulus was followed by a response would lead to the prediction of behavior. Watson's S-R model of behavior, that behavior is the sum of S-R associations, is the basis for behaviorism

Originally Watson (1913) accepted the existence of private events, that is, events observable only to the subject. For example, a headache is quite real to the person with the headache yet it is often observable only to that person. Others, as most often the case, do not discover that the person has a headache until the subject reports it. To deal with such events within the context of a S-R model of behavior where the basic datum is publicly observable events, a definition of private events

within publicly observable terms is required. Unfortunately, due in part to the controversy that was spirited by Watson's view, Watson (1924) soon found himself adopting an extremist position and denying the very existence of private events.

The extreme behavioral view which rejects the very existence of private events has few adherents today. Instead, a number of different positions have developed. One position based upon Watson's (1913) original view continues to influence North American psychology through the behavioristic stance advanced by B. F. Skinner. Skinner (1953, 1974) argues that private events are legitimate objects of study provided they are accessible to others. This involves defining private events so that they are subject to objective observation and measurement, the sine qua non of science. Another position held by some psychologists (e.g., Kendler & Kendler, 1975) utilzes the concept of mediation.

Mediation

For the purpose of this thesis the following definition of a mediator is adopted:

> The mediator is a response, or series of responses, which intercedes between the external stimulus and the overt response to provide stimulation that

> influences the eventual course of behavior. These responses may be overt, but they are usually presumed to be covert. (T. S. Kendler, 1963, p. 34).

Before continuing, a qualification regarding T. S. Kendler's definition of a mediator needs to be noted. A source of confusion with the definition lies with the statement that the mediator is "usually presumed to be covert", that is, publicly unobservable. Different ways of dealing with this covert aspect of a mediator have arisen. Some researchers (e.g., Ellis, 1970) quite simply view mediators as hypothetical constructs and thus, by definition, not directly observable to others. For these researchers hypothesizing mediators serve an explanatory function (Kendler & Kendler, 1975).

Other researchers (e.g., Flavell, 1970) adopt a position advocated by the behaviorism of Watson (1913) and Skinner (1953, 1974). Covert mediators are made overt by defining them as publicly observable events. One manner of achieving this goal is to view mediators as verbal responses. This then allows psychologists to observe the occurrence of verbal responses and to chart their functional relationship to behavior.

Verbal Production Deficiency

A number of studies directed at other issues have noted that for some young children verbalization does not appear to influence behavior (Kendler & Kendler, 1962; Kuenne, 1946; Luria, 1957). Such anecdotal reports led Reese (1962) to formulate the mediational deficiency hypothesis. This hypothesis states that up to a certain point in the child's development verbal responses fail to function as mediators; however, after that point they do function effectively as mediators.

The failure by a verbal mediator to influence behavior may result from one of two possibilities. First, the verbal mediator may occur but it quite simply fails to influence behavior despite its occurrence. This is essentially Reese's (1962) formulation of the mediational deficiency hypothesis. This possibility was re-labelled by Kendler (1972) as a control deficiency to distinguish it from a second type of mediational deficiency.

The second possibility is called a verbal production deficiency (Flavell, Beach, & Chinsky, 1966). A verbal production deficiency is said to be evident when a child fails to produce a verbal label (mediating response) which, if produced, would facilitate overt performance.

Flavell and his co-workers (Flavell et al, 1966) were the first to demonstrate the possibility of a verbal production deficiency. In this initial study, 60 children ranging in age from 69 months to 129 months were observed as they performed a serial recall task. The experimenter pointed randomly to three of seven pictures presented and, after a 15 second delay, the children were required to select the same three pictures in the same order from a duplicate set of pictures. During the delay interval the original set of pictures were removed from sight and a duplicate set of pictures were exposed at the end of the delay.

The pictures were concrete objects (e.g., comb, apple) that were known to the child (i.e., they could be named). Consequently it was expected that this task might elicit verbal mediation responses (picture naming) during the delay interval. Adults report that they repeat verbal labels representing pictures and this verbal labelling facilitates recall (Adams, 1967).

The results revealed the older children as more accurate in their recall and also more verbal during the delay as compared to younger children. Furthermore, children from the same age group who verbalized or named the pictures performed significantly better in the recall

task than children who remained silent.

The Flavell et al (1966) investigation demonstrated that some young children performing a serial recall task can be characterized as having a verbal production deficiency. That is, these young children failed to utilize the verbal skills within their repertoire that are useful in the memory task. However, their study demonstrated only a correlational relationship between verbalization and performance in a recall task. There was no direct manipulation of the verbal behavior and thus, no cause-effect statement could be made.

In a subsequent study, Keeney, Cannizzo and Flavell (1967) directly manipulated the children's verbal behavior. Eighty-nine children with a mean age of 82 months were exposed to the same serial recall task as described in the earlier study (Flavell et al, 1966). Once again it was found that the children who spontaneously named the pictures performed better in the serial recall task than the children who were silent.

Seventeen children did not verbalize even though they could label the pictures correctly. These 17 "nonproducers" (verbal production deficient children) were then instructed by the experimenter to name the picture before the start of the delay interval. Inducing these children to use a verbal mediator resulted in

recall performance indistinguishable from the recall performance of children who spontaneously used a verbal mediation strategy. All the nonproducers benefited from instructions to verbalize. However, 10 of the 17 verbal production deficient children abandoned the use of a verbal mediator when instructions to verbalize were withdrawn. When these children discontinued their picture naming, recall performance returned to its previous less accurate level.

The Keeney et al (1967) study replicated the earlier findings (Flavell et al, 1966). That is, some young children were observed not utilizing a verbal mediation strategy despite the fact that they have the necessary verbal skills. Furthermore, children with a verbal production deficiency can be instructed to use a verbal mediation strategy that results in improved recall. This latter point has now been demonstrated sufficiently often to be widely accepted (Flavell, 1970; Hagen & Kingsley, 1968; Moely, Olson, Halwes, & Flavell, 1969).

Given the validity of conceptualizing some young children as verbal production deficient and given the finding that instructing these children to use verbal mediators is effective, many investigators have turned to the investigation of mediation among atypical individuals.

Mediation and the Atypical Individual

Studies have shown that the mentally retarded (Clarke & Clarke, 1974; Ellis, 1963), autistic (Bryson, 1972; Lovaas & Newson, 1976; Prior & Chen, 1976), psychotic (Hagen, Winsberg, & Wolff, 1968) and learning disabled individuals (Bauer, 1977) perform poorly in tasks involving a delay between the presentation of a stimulus and the production of a response. Attempts to explain this behavior have all dealt, in one manner or another, with the individual's failure to use a strategy within his or her behavioral repertoire that would result in more accurate recall.

An illustration of an attempt to explain the poor recall performance of some atypical individuals is provided by Ellis (1963, 1970). In one series of studies, Ellis (1970) investigated normal-retardate differences in the accuracy of recall over brief delays (seconds). The subjects were retardates and college students of the same age level (mean age of 20 years). They sat before an apparatus which consisted of a horizontal row of nine response keys with a tenth key positioned above the row. Each of the horizontal keys were briefly illuminated with either a random series of numbers or

a random series of letters. Both the numbers and letters were familiar to the subjects..

All the stimuli were illuminated in a sequential manner. After the nine stimuli were shown, the tenth key was illuminated with one of the nine stimuli previously shown (probe stimulus). The subjects' task was to press the now blank horizontal key that indicated the position where the probe stimulus was last seen.

In serial position recall tasks similar to the one just described adults typically recall the stimulus items near the beginning and near the end more accurately than the items in the middle of the series (McCracy & Hunter, 1953). It is presumed that items near the end of the series, since the delay between stimulus presentation and recall is short, are recalled accurately because the stimulus information is still available in a "short-term memory store" (Loftus & Loftus, 1976). This finding is referred to as the "recency effect".

The short-term memory store is a hypothetical structure which supposedly stores information for brief periods of time, usually measured in seconds. Without some sort of active manipulation by the subject, the information in the short-term-memory store is postulated to fade from storage and thus become inaccessible for recall (Waugh & Norman, 1965).

The accurate recall of items at the beginning of the series is called the "primacy effect" (McCracy & Hunter, 1953). The primacy effect is hypothesized to be the result of the subject's use of a rehearsal strategy. Rehearsal is defined as the verbal repetition of the stimulus items and rehearsal may be either private of publicly observable. Presumably rehearsal holds information within the short-term memory store thus maintaining the availability of the information for recall.

The middle items have a low probability of recall for two reasons. First, they are not rehearsed because the subject is assumed to be busy rehearsing the initial items. Second, by the time the subject is required to recall the items, the information has faded from the short-term memory store (Peterson & Peterson, 1959).

Ellis (1970) found that the retardates showed no primacy effect suggesting, in terms of the model just presented, a failure by the retardates to rehearse the stimulus items. Even varying the rate of stimulus presentation to allow more time to rehearse the information benefited only the college students (Study 1). These findings led Ellis (1970) to formulate the rehearsal strategy deficiency hypothesis. The hypothesis states

that retardates perform poorly in delay tasks because they fail to rehearse the stimulus items.

The rehearsal deficiency hypothesis proposed by Ellis (1970) is remarkably similar to the verbal production deficiency observed among young children (Flavell, 1970). In both cases, the individual's failure to perform accurately in delay tasks is thought to be related to the inefficient use of existing language skills. The difference between Ellis' and Flavell's formulations lies in the model they employ.

Ellis (1970) employs an information processing model. In this model, stimuli are stored in hypothetical structures (e.g., short-term memory store) and these stimuli are subjected to publicly unobservable processes (i.e., rehearsal). Ellis (1970) admits that the model provides only "conceptual anchors" but argues for the model's use as a necessary beginning step in the investigation of the behavior of retardates in memory type situations.

Flavell (1970) does not depart from publicly observable anchors to the same extent as Ellis (1970). Hypothetical structures are not assumed and verbal mediators are defined as publicly observable events. In Flavell's series of experiments the children's use of verbal mediators were directly observed. For example, in the Keeney et al (1967) study the children were observed

talking out loud and in the Flavell et al (1966) study lip movements were "read" by a trained lip reader.

Although Ellis' and Flavell's formulations differ, the fact remains that retardates exhibit behavior similar to that of young children when performing in a delay task. Furthermore, a reasonable explanation in both cases is that the individuals have failed to utilize existing verbal mediators. That is, both young children and retardates display a verbal production deficiency. The reader is also reminded that both positions are consistent with T. S. Kendler's (1963) definition of a mediator. Within the context of her definition, the individuals studied by Ellis and Flavell may be characterized as failing to produce a response sometime between the presentation of the external stimulus and the occurrence of the final response which can potentially influence the course of behavior.

Some investigators have suggested that the failure to utilize existing verbal mediators by retardates is due to a defective central nervous system (e.g., Luria, 1963). The empirical support for this assertion is sorely lacking (Zigler & Balla, 1971). As Campione and Brown (1977) point out, a critical test for a central nervous system deficit explanation of a verbal production deficiency is whether or not the retardate responds to

training. At present, the empirical evidence supports the position that the verbal production deficiency can be corrected by training.

A study by Kellas, Ashcraft and Johnson (1973) demonstrated the effectiveness of training retardates to use verbal mediation in a recall task (the authors used the term "rehearsal"). Ten adolescent retardates with a mean IQ of 70 were instructed to repeat aloud the experimenter's labelling of a series of pictures. Familiar objects were represented in the pictures. For this group of subjects only two trials in which the experimenter labelled the pictures were required before the subjects continued to use the verbal labels without prompts.

A second group of subjects was instructed to repeat the experimenter's verbal labels silently and a control group received no instructions to repeat the experimenter's verbalizations. After a delay interval (30 seconds in Experiment 2) the subjects were required to recall the order of picture presentation.

The results indicated that instructions to use verbal mediators either overtly or covertly produced a higher accuracy of recall than if no instructions were given. In the control group no observable verbal behavior was evident and recall performance was poor. In addition to

these short-term effects, a re-test two weeks later revealed that the instructed groups continued to perform more accurately than the noninstructed group.

The group that was instructed to overtly label the pictures continued to do so two weeks later. The group that was instructed to covertly label the pictures was presumed to do so in the follow-up test; their covert labelling was inferred from their accurate recall performance.

The Kellas et al (1973) study not only highlights the effectiveness of training in overcoming a verbal production deficiency but it is also one of the few studies demonstrating the maintenance of a verbal mediation strategy over an extended period of time.

Why the intellectually retarded subjects in the Kellas et al (1973) study continued to use a verbal mediation strategy two weeks after training whereas intellectually normal children (Keeney et al, 1967) quickly abandon such a strategy is unclear. The answer may lie with differences in the extensiveness in the training procedures between the two studies. However, Kellas et al (1973) fail to provide detailed information as to the length and extensiveness of their training procedure. One can only speculate that their training procedure may have been more rigorous and systematic than the Keeney et al (1967) study.

In the Kellas et al (1973) study the subjects usually

labelled the stimuli as they appeared one at a time. Butterfield, Wambold and Belmont (1973) visually presented letters in a series of three followed by a pause. During the pause the subjects in the experimental condition were required to verbally label the letters aloud. The subjects were 24 retardates with IQs ranging from 52 to 85 (no mean IQ was reported) and ages ranging from 13 to 21.

Instructing the subjects to verbally label the letters in groups of three produced highly accurate recall. Without instructions to verbally label the stimuli the subjects remained silent and recall performance was poor.

One week later the subjects' retention of the verbal mediation strategy was reassessed. Less use of the verbal mediation strategy and a small but significant drop in recall accuracy was found. Neither the use of verbal mediators nor recall accuracy returned to pre-training levels.

Although the study did show that retardates could be trained to continue using a verbal mediation strategy over a period of time, the failure by Butterfield et al (1973) to find the same high performance levels as reported by Kellas et al (1973) deserves comment. One factor to account for the discrepant findings may be differences in training procedures. However, both studies fail to provide the necessary information to

evaluate this possibility. Furthermore, neither study explicitly programmed training in the use of verbal mediators for purposes of long-term retention. The training consisted simply of instructions to verbalize. Correct verbalization was not systematically reinforced.

A second factor that may account for the discrepant results reported by Kellas et al (1973) and Butterfield et al (1973) is the difference in the stimuli that were used. Verbally labelling letters (Butterfield et al, 1973) may be more difficult for retarded individuals than verbally labelling more common stimuli such as concrete objects (Kellas et al, 1973).

A third source of variability is the experimental manipulation itself. The subjects in the Butterfield et al (1973) study were instructed not only to use a verbal mediation strategy but were also simultaneously trained to use an additional strategy. The training of multiple strategies may have interfered with the long-term retention of the verbal mediation strategy.

In general, most studies investigating verbal mediation deficiencies in retarded individuals have employed mildly retarded individuals (IQs over 50). Furthermore, most studies have shown that these individuals do not spontaneously use verbal mediators when the task

requires it but that they can be trained to do so (Belmont & Butterfield, 1971; Brown, 1972; Butterfield et al, 1973; Kellas et al, 1973; Turnbull, 1974).

The prevalence of a verbal production deficiency also appears to extend to psychotic and learning disabled children. For example, Hagen, Winsburg and Wolff (1968) observed ten psychotic children (mean age of 8.4 years, IQs were not provided) perform a serial recall task. The children showed a verbal production deficiency; they failed to use existing verbal skills as mediators. The experimenter then named the concrete objects depicted in the pictures for the children. That is, the verbal mediator was provided by the experimenter and it was not produced by the children. Nevertheless, recall performance improved significantly.

Another example of a study employing a different group of atypical individuals is a study by Bauer (1977). Nine and ten year old learning disabled children of average intelligence (mean IQ of 100) were exposed to a serial recall task involving pictures and their performance was compared to the performances of normal children.

Unlike the normal children, the learning disabled children displayed no primacy effect. That is, they failed to rehearse or utilize verbal mediators.

Unfortunately, no attempt was made to train the children to utilize a verbal mediation strategy. This would have yielded information regarding the effectiveness of training such a strategy with learning disabled children.

Thus far, the sampling of experiments cited indicate that verbal production deficiencies are evident among a variety of subjects. Verbal production deficiencies have been observed among young, normal children, learning disabled and psychotic children and mildly retarded individuals. Furthermore, at least for short periods of time, the deficiency can be eliminated by formal training in the use of verbal mediators.

Most studies however, have involved individuals with normal intelligence or individuals of mild intellectual retardation. The paucity of studies with individuals of more severe intellectual impairment may be due in part to the difficulty in finding a task that makes little intellectual and language demands on the subject yet would benefit from verbal mediation.

One study (Constantine & Sidman, 1975) did assess verbal production deficiencies among severely retarded individuals. It also demonstrated the effectiveness of a verbal mediation strategy for these individuals.

Before examining this study a detailed description of the task employed, a delayed matching-to-sample task, is provided since the task is also employed in the present thesis.

The Matching-to-Sample Task

The matching-to-sample (M-T-S) task involves the presentation of a stimulus, called the sample, along with two or more comparison or choice stimuli. The subject's task is to select from the comparison stimuli presented the stimulus that matches the sample stimulus. The subject indicates his selection, in most experiments, by touching the appropriate choice stimulus. No verbal response is required.

The stimuli in most M-T-S experiments are visually presented (e.g., pictures of objects, colors, etc.) although this is not necessary. Cross-modal matching (e.g., an auditory sample with picture comparison stimuli) is also a frequently used procedure.

A match can result from the sample and choice stimuli being physically identical such as when the sample stimulus is the letter M and the correct choice stimulus is the identical letter M. This is called identity matching.

A match can also result when the sample and choice stimuli are not physically identical but functionally related. This is called symbolic matching (Carter & Werner, 1978) or nonidentity matching (Constantine & Sidman, 1975). Examples of nonidentity or symbolic matching are a picture of a limousine as the sample and a picture of a sports car as the correct choice or, the word "car" presented orally as the sample and a picture of a sports car as the correct choice stimulus.

The introduction of a delay between the presentation of the sample stimulus and the choice stimuli is called delayed matching-to-sample (D-M-T-S). The sample stimulus is usually exposed to the subject for a brief period of time and it is then withdrawn. A predetermined delay interval follows and ends with the presentation of the choice stimuli. The subject is required to choose the stimulus that matches the sample stimulus previously shown.

The D-M-T-S task was first employed in 1913 by Hunter to explore the symbolic processes of organisms with limited verbal capabilities, namely animals. Subsequently, the task has found widespread use in the investigation of animal learning (Carter & Werner, 1978; Roberts & Grant, 1976; Shimp, 1976; Weinstein, 1941). Furthermore, the D-M-T-S task has recently been applied

to humans with limited verbal capabilities. Examples are brain damaged, intellectually normal children (Rosenberger, Stoddard, & Sidman, 1972), aphasic adults (Sidman, 1971) and patients with severe memory disorders (Sidman, Stoddard, & Mohr, 1968).

The advantages of a D-M-T-S task are twofold. First, the response required by the subject is nonverbal and thus the task can be used to study the behavior of subjects with limited verbal skills. Second, the matching task is relatively simple and it can be performed by subjects of limited intellectual capabilities. The D-M-T-S task was selected by Constantine and Sidman (1975) as the vehicle to study verbal production deficiencies among severely retarded individuals.

The Constantine and Sidman (1975) Study

Using four severely retarded adults as subjects (ages ranged from 17 to 22 years and IQs ranged from 20 to 35) Constantine and Sidman (1975) set out to determine: (a) whether or not severely retarded individuals showed verbal production deficiencies and, (b) if they were verbal production deficient, whether instructions to use verbal mediators would facilitate performance. A D-M-T-S task with pictures was selected since it was

presumed likely that utilizing a verbal mediation strategy in this task would result in more accurate matching.

The first step was to demonstrate a verbal production deficiency. To accomplish this, four conditions had to be met. First, the subjects must be able to correctly match a choice stimulus to the sample stimulus when the sample stimulus is immediately available. Second, the subjects must do poorly in a task where verbal mediation is expected to be helpful. That is, they must perform poorly in the D-M-T-S task. Third, the verbal mediating response must be within the subjects' behavioral repertoire. That is, the subjects must be able to name the sample picture. Finally, if the verbal mediator is provided for the subjects by the experimenter it must lead to improved performance even at delays where the subjects performed poorly in the D-M-T-S task.

The stimuli were drawings of concrete objects (e.g., car, dog, cow). Both identity matching (e.g., a Volkswagon car to a Volkswagon car) and nonidentity matching (e.g., a Volkswagon car to a sports car) were required. Furthermore, all the subjects could correctly name the stimuli.

Experiment 1 tested for a verbal production deficiency. Of the four subjects, three were verbal production deficient.

Experiment 2 tested the effectiveness of a verbal mediation strategy. The three verbal production deficient subjects from Experiment 1 were instructed to name the pictures before the delay interval began. The effectiveness of this verbal mediation strategy was evaluated by comparing matching performance in the D-M-T-S task for each subject under two conditions: (a) subject verbally labelling the picture and, (b) subject silent.

The results of Experiment 2 showed matching performance in the D-M-T-S task to range from approximately 12% when the pictures were not named to between 80% and 100% when the pictures were named. The subjects required constant prompting from the experimenter to use the verbal mediation strategy. Without the prompts the subjects stopped producing the verbal mediator and matching accuracy in the D-M-T-S task returned to the 12% level. The subjects were not specifically trained to continue using verbal mediators without the need of prompts from the experimenter.

Three features of the Constantine and Sidman (1975) study are worth noting. First, the study demonstrated the usefulness of the D-M-T-S task in assessing production deficiencies among severely handicapped individuals. Second, the study demonstrated that not only can some severely retarded individuals be characterized as verbal production deficient but that the deficiency can be

overcome by training in the production of the appropriate verbal mediator. Third, a small N design (Sidman, 1960) was employed to assess both the presence of a verbal production deficiency and the effectiveness of a verbal mediation strategy.

Until the Constantine and Sidman (1975) study all previous studies had employed group designs wherein groups of subjects are exposed to different treatment manipulations and statistical procedures are used to evaluate the effectiveness of different levels of treatment. Constantine and Sidman (1975) used only four subjects (three in Experiment 2) but by systematic variation of the independent variable (picture naming) large variations in the dependent variable (matching accuracy) were observed.

These large variations in the dependent variable were observed both within subjects and across all three verbal production deficient subjects. The improved matching accuracy under the instructed verbal mediation condition was so large that a statistical test of the effect of the verbal mediation strategy upon matching accuracy was not required. A more complete discussion of the small N research design will be presented later.

Summary of Verbal Mediation with the Atypical Individual

A sampling of the studies investigating the failure of mentally retarded, psychotic and learning disabled individuals to perform accurately in delay tasks has suggested that the source of the difficulty may centre with their failure to utilize existing verbal strategies. Thus far, however, we have discussed only verbal production deficiencies and the effectiveness of instructing individuals with varying dysfunctions to use verbal mediators. By and large we have observed that instructing these individuals to use verbal mediators results in the elimination of a verbal production deficiency. The question now arises as to whether a production deficiency can be nonverbal.

Nonverbal Mediation

Kendler and Kendler (1975) have lamented that many researchers view mediators as strictly verbal in nature. There have been few empirical investigations of potential nonverbal mediators. Three notable exceptions are provided by Flavell and his co-workers. The basic premise underlying their work is that a common feature of a mediator is its symbolic feature and thus a mediator does not necessarily need to be verbal.

In the first study, Corsini, Pick and Flavell (1968) presented kindergarten and first grade children with seven visual patterns composed of circles, squares and triangles. The children were to study a test pattern afterwhich the test pattern was removed from sight. They were then required to reproduce the test pattern with wooden forms that were provided. Also available to the children during the exposure of the test pattern were paper forms that could be used to duplicate the test pattern.

All the children were given the instruction to use the paper forms to "help yourself remember". The experimental group received additional prompts. Before the fourth of seven trials the children in the experimental group were asked to make a paper form copy of the test pattern. In addition, before the seventh trial, the experimenter presented a paper pattern and asked the children to copy the pattern with the wooden blocks provided. Thus it was ascertained that the children were capable of using the paper forms as nonverbal mediators.

The results showed that the kindergarten children failed to utilize the paper forms as a nonverbal mediator despite the fact that they had the necessary component skills. The older children not only performed better in the recall task than the kindergarten children but more

of them were likely to use the paper forms as nonverbal mediators.

In addition to the above findings, the kindergarten children that did respond to the prompts to use the paper forms performed better in the recall task than the kindergarten childen who did not use the paper forms. Thus, the study demonstrated that mediational deficiencies need not be verbal in nature and that a nonverbal mediation strategy can be an effective strategy for some delay tasks.

A second study by Ryan, Hegion and Flavell (1970) examined the ability of nursery school children ranging in age from 3 years to 5.6 years to utilize a nonverbal mediation strategy in a recall task. Toy animals were placed in "cages" divided by sliding doors. The children were instructed to note where the animals lived afterwhich the animals were placed behind the sliding doors and concealed from view. The children were then required to place a duplicate set of toy animals in front of the cages taking care not to place animals of different species with the animals in the cages (e.g., a lion with a monkey).

During the initial exposure of the toy animals, pictures of the animals were available to the children. The experimenter suggested to the children that the pictures could be used while the doors were open to help them with the task. Twenty-eight of the 50 children

spontaneously used the pictures by placing the appropriate picture in front of the animal cages thereby insuring accurate recall. More direct instructions (experimenter modeling the appropriate behavior) led to a total of 42 childen using the pictures as mediators.

A third study (Daehler, Horowitz, Wynns, & Flavell, 1969) stands in contrast to the two previous studies that found nonverbal mediators to be an effective strategy in some delay tasks. Children ranging in age from six to ten years were exposed to two tasks. Only the second task involving gestural mediation is relevant to the present discussion.

A sequence of colors were randomly presented on a panel and the children were required to recall the sequence of spatial positions at which the lights appeared. The delay interval was 15 seconds and the response was demonstrated by placing plastic chips over the appropriate locations on the display panel in the same temporal order as the lights were shown.

It was hypothesized that the older children would utilize a gestural mediator. That is, they would point to the different locations where the lights appeared during the presentation of the stimuli. The hypothesis failed to receive empirical support. Although 22 of the 40 children did point in at least one trial, pointing was not used consistently by them. Furthermore, pointing

was related neither to age nor to recall performance.

Daehler et al (1969) were at a loss to explain the failure of pointing to function as an effective mediator. The most parsimonious explanation may be that there is no good reason to suppose that normal children would adopt a pointing strategy. This explanation does not exclude the possibility that gesturing can function as a mediator. A more appropriate test is to choose a situation in which gesturing naturally plays a more important role. To this we now turn our attention.

Sign Language and the Atypical Child

The usefulness of instructing atypical children (e.g., retarded and psychotic children) to use verbal mediators in the appropriate situation appears to be a worthy pursuit for clinicians and educators. Yet, the procedure remains useful only to those individuals already possessing some verbal skills. There are children who lack any verbal skills. For these children the possibility exists that nonverbal mediators rather than verbal responses may be brought to function as effective mediators.

Severe verbal deficits are a common feature among the intellectually handicapped (Mittler, 1974) and they are considered by many to be a major feature of autistic children (Churchill, 1972; Creak, 1972; Ricks & Wing,

1975; Rutter & Bartak, 1971). Attempts to teach autistic children speech have required enormous efforts from teachers (cf. Lovaas, 1967) and these efforts have frequently resulted in disappointing long-term effects (Lovaas, Koegal, Simmons, & Long, 1973).

Recently investigators have sought alternative forms of communication that would be easier to train and that would provide more stable effects over time. Some of the initiative has come from attempts to teach animals communication skills. For example, Premack (1971) has developed a "plastic language" in order to communicate with nonhuman primates. Pieces of plastic varying in size, shape and color come to represent words in the English language by the systematic association of the plastic chips with the English word referents.

The advantages of using a plastic language to communicate with nonhuman primates are obvious. It does not require speech and it is relatively permanent thus freeing the language from memory constraints. Perhaps of more importance is that the plastic language has proven successful in communicating with nonhuman primates. For example, one of Premack's (1971) chimpanzees, Sarah, achieved a vocabulary of over 130 words which included verbs and adjectives. She also emitted sentences and even posed questions to the experimenter.

Encouraged by the success of the plastic language in communicating with chimpanzees, Premack and Premack (1974) used the language with a mute autistic child. This eight year old boy, who had no language skills beyond some word recognition skills, was exposed to the same language training procedure as the other two chimpanzees in Premack's (1971) earlier study.

Although extensive data was not provided, Premack and Premack (1974) suggested that the plastic language did have some positive impact upon language usuage. The child began to comprehend complex sentences and he began to comprehend the plural use of words (e.g., he was able to differentiate between "take cookie" and "take cookies").

Variations of the Premackian language are also found outside the specialized primate laboratories. For example, the Blissymbolics Communication System is widely used with physically and intellectually handicapped children (Archer, 1977; Silverman, Note 1). Line drawings on a permanent display board replace Premack's plastic chips and the display board is carried about by the user. In communicating, the subject points to the different line drawings each of which represents a word or concept.

An alternative to speech training and training in a Premack-type language is training in sign language (usually American Sign Language or ASL), a manual form

of communication (Reikehof, 1963). Sign language is not only widely used by the deaf but it also has been taught with some success to nonhuman primates (Fouts, 1972; Fouts, Chown, & Goodin, 1976; Gardner & Gardner, 1969).

Teaching sign language to nonverbal mentally retarded and autistic children may circumvent some of the assumed perceptual deficits in these children. Difficulties with crossmodal associations, usually visual-auditory associations, have been noted among speechless psychotic and mentally retarded children (Dalgleish, 1975; O'Connor & Hermelin, 1965). Bryson (1970) has observed that some psychotic children display a particular inability to utilize auditory stimuli in association with visual stimuli. She then argued that these perceptual difficulties (i.e., an inability to simultaneously utilize auditory and visual stimuli) accounted for the observation that some psychotic children are unable to generate verbal labels for visual stimuli. Generating verbal labels for visual stimuli is a skill considered necessary for performing some tasks (e.g., reading).

Lovaas and his associates have provided evidence that verbally impaired autistic and mentally retarded children respond differentially to information presented in different sensory modalities. When presented with a

complex stimulus composed of auditory, visual and tactile cues, verbally deficient children responded to only one or two of these cues and never responded, as the normal children did, to all three cues (Lovaas, Schreibaum, Koegel, & Rehm, 1971). This finding is called "stimulus overselectivity" by Lovaas et al (1971).

Although stimulus overselectivity may be a common feature among verbally impaired retarded and autistic children (Wilhelm & Lovaas, 1976), it may be amenable to training. For example, Lovaas and Schreibaum (1971) trained verbally deficient autistic children to respond to a previous nonfunctional sensory stimulus through the manipulation of appropriate reinforcement contingencies.

Other investigators (Condon, 1975; O'Connor & Hermelin, 1965; Tubbs, 1966) have argued that some autistic and psychotic children have a specific auditory deficit. For example, Condon (1975) provided evidence suggesting that autistic children have difficulty in synchronizing their own sounds with the speech produced by others.

Whatever the assumptions (i.e., crossmodal associations, stimulus overselectivity, auditory deficit) for using a nonverbal form of communication that uses only one sense modality, an explicit rationale for teaching sign language to nonverbal, dysfunctional children has only recently been presented (Konstantareas, 1977; Oxman, Webster, &

Konstantareas, in press). The use of sign language programs appear instead to be a reaction to the failure of speech training programs.

One of the first published studies investigating the use of sign language to communicate with a mute autistic child devoted three pages to a description of a speech training program that ended in failure (Webster, McPherson, Sloman, Evans, & Kuchar, 1973). In both practise and in reported studies, many speech deficient children are first exposed to speech training programs. Failure in training speech is then followed by a sign language training program (Bonvillan & Nelson, 1976; Salvin, Routh, Foster, & Lovejoy, 1977).

Demonstrations that sign language is a viable alternative to verbal communication for some nonverbal children have increased over the past few years (see reviews by Kiernan, 1977; Webster, Konstantareas, Oxman, & Mack, in press). Typically it has been reported that the acquisition of signs occur at a faster rate than the acquisition of speech. Hardly a child fails to learn some signs (cf. Kiernan, 1977). Not only do these children learn signs with relative ease, but some even develop verbal expressive skills without direct training (Benaroya, Wesley, Ogilvie, Klein, & Meaney, Note 2; Fulwiler & Fouts,

1976; Miller & Miller, 1973; Topper, 1975).

Investigators have also reported that some children trained in the use of sign language have been observed signing to themselves in what appears to be the use of a sign-word to influence their own behavior (Bonvillan & Nelson, 1976; Webster et al, 1973). This spontaneous signing may be analagous to the verbal mediation strategy used by verbally proficient individuals. However, the present evidence rests only upon anecdotal information and whether or not signing to oneself can function as a nonverbal mediator remains to be experimentally tested.

The possibility that signing can function as a nonverbal mediator is suggested by the noted anecdotal evidence and by two other sources. One source is the evidence presented by Flavell and his co-worker demonstrating the effectiveness of nonverbal mediators (Corsini et al, 1968; Ryan et al, 1970).

Another source of evidence suggesting the feasibility of using sign as a nonverbal mediator are the studies demonstrating the functional similarities of ASL to verbal language. ASL has been shown to have its own grammar and system of rules (Bellugi & Fischer, 1972). Furthermore, Bellugi, Klima and Siple (1975) have shown that within the structure of a memory task confusional errors to signs are based upon the visual properties of

the signs. This is similar to the acoustically based errors observed among hearing subjects (Wickelgren, 1965). If, in some respects, sign language functions like verbal language, then it is not unreasonable to expect sign language to function as a mediator in a manner resembling verbal mediation.

The Present Study

In the review of the literature a number of observations were made. In summary fashion they are the following:

1. Young normal children and atypical individuals can be characterized as having production deficiencies.
2. Production deficiencies can be eliminated with appropriate training in the use of a mediational strategy.
3. Mediators can be nonverbal.
4. It is reasonable to expect, although it has never been directly tested, that sign language can function as a nonverbal mediator for production deficient children.

The major intention of the present study is to:

(a) Assess whether some verbal deficient children being trained in the use of sign language

can be characterized as having a sign production deficiency.

(b) Assess whether sign language can function as an effective mediator for sign production deficient children in a D-M-T-S task.

Four autistic children trained in the use of sign language were required to perform a D-M-T-S task. The D-M-T-S task was chosen since it was reasoned that performance in this task would benefit from a mediational strategy. Furthermore, the D-M-T-S task is a relatively simple task and it requires no verbal skills.

In order to demonstrate the existence of a sign production deficiency the following conditions had to be met. First, the children must be able to correctly match a choice stimulus to the sample stimulus when the sample stimulus is immediately available. The sample stimuli were pictures in Experiment 1 and auditorally presented words in Experiment 2. Second, the children must perform poorly when the sample stimulus is not immediately available. That is, they must perform poorly in the D-M-T-S task. Third, the children must be able to select the appropriate choice stimulus even after a delay when the sample is a sign presented by the experimenter. Lastly, the children must be able to "name" the stimulus by producing the appropriate sign.

If all these conditions are met then, by definition, the children have a sign production deficiency.

Following the assessment of a sign production deficiency those children with a sign production deficiency were instructed to produce the appropriate sign in the presence of the sample stimulus in the D-M-T-S task. The accuracy of the children's matching responses was then compared to their matching behavior when they did not sign in the presence of the sample stimulus. The children were also trained, through the systematic use of reinforcement, ~~to~~ produce the appropriate sign without constant prompting from the experimenter. Thus, the effectiveness of signing as a verbal mediator on delayed matching accuracy and its susceptibility to training were assessed.

Beyond the major intents of this thesis, that is, the assessment of a sign production deficiency and its elimination through training in a sign mediation strategy, a number of other issues were addressed. One issue is the efficacy of a sign mediation strategy for both auditorally and visually presented stimuli. Most studies demonstrating poor performance in "memory" tasks by autistic and mentally retarded children have used visually presented stimuli (Bryson, 1972; Kellas et al, 1973; Hermelin & O'Connor, 1965). However, poor recall performance when the stimuli

are auditory in nature has also been reported (Neufeldt, 1966).

Although most experiments support the idea that autistic and mentally retarded children perform poorly in memory tasks, Lowry and Ross (1975) raise the possibility that their poor performance may be an experimental artifact rather than a memory deficit of some sort. In their study severely retarded children (mean age of 14.2 years and IQs ranging from 20 to 35) were classified as either impulsive or reflective. The impulsive children were those demonstrating the shortest response latencies and fewest correct responses in a picture matching task. However, if the impulsive children were prevented from responding for an extra five seconds their performance in the matching task improved. This finding suggests a need to control for impulsive responding when investigating performance in a recall task since poor performance may reflect impulsive response styles rather then a poor memory.

Most training programs hope to show effects beyond the training situation itself. For example, if the child learns a new behavior in the classroom it is expected that the behavior will also occur in the appropriate situation outside the classroom. The production

and maintenance of newly learned language behavior in situations different from the taining situation has been exceedingly difficult to achieve with autistic children (Lovaas et al, 1973).

In many sign language programs signing behavior generalizing to other settings and even facilitating nonlinguistic behavior has been reported. Claims in behavior change range from the learning of toiletting skills (Bonvillan & Nelson, 1976), following sign instructions given by strangers (Webster et al, 1973) to the spontaneous use of speech (Miller & Miller, 1973). The majority of these claims have been anecdotal.

In addition, there have been few attempts to assess whether or not the children continue to use sign language after the completion of a training program (Konstantareas, Note 3). Obviously a more rigorous assessment of the effects of sign training to other behaviors and situations is needed to properly evaluate the importance of sign language programs.

In summary, two major hypotheses were tested. The first hypothesis is that autistic children proficient in the use of sign language would demonstrate a sign production deficiency in a memory situation. The second hypothesis is that signing would function as a nonverbal

mediator that would overcome the production deficiency.

Also a number of minor issues were addressed. They were: (a) the effectiveness of sign mediators with different stimulus modalities (visual and auditory), (b) the role of impulsive response styles in delayed matching performance and, (c) the generalizability of a sign mediation strategy.

To evaluate the effectiveness of sign as a nonverbal mediator a small N or single subject approach was employed. The design used was a simple reversal or A-B-A design (Baer, Wolff, & Risely, 1968). In an A-B-A design the effect of the experimental variable (i.e., signing the sample stimulus) upon behavior (i.e., matching accuracy) is evaluated by comparing behavior under two conditions. In the baseline condition (A) behavior is observed in the absence of the experimental variable. In the treatment phase (B) the experimental varaible is applied and the behavior is observed.

Control of the experimental variable over behavior is demonstrated when the behavior changes between conditions A and B. In this thesis, increased matching accuracy is expected in condition B as compared to condition A. Removal of the experimental variable should result in a reversal of behavior to baseline conditions. The more reversals that are demonstrated (e.g., A-B-A-B...) the more likely that the experimental variable and not

some extraneous variable is producing the observed change in behavior.

Replicating the effects of the experimental variable in other subjects further adds to our confidence in the findings. Of course, across subject replication also adds to the generalizability of the results.

The small N or single subject approach was chosen for a number of reasons. First, there are relatively few autistic children trained in sign language. In the Ottawa area only four such children were available to the author. The small numbers necessarily excluded a group design approach. When a researchable problem or the subject population is numerically rare a single subject approach is the only alternative that allows for experimental investigation (Dukes, 1965).

Second, group studies require a statistical averaging which obscures individual behavior. For the clinician whose major interest is the treatment of individuals, generalizing from group studies to the individual case may be problematic (Hersen & Barlow, 1976).

Finally, for the clinician powerful treatment methods are needed if the treatments are to have practical utility. Most single subject research relies upon visual inspection of the data to evaluate treatments, and thus, only powerful treatment can be evaluated (Baer, 1977). Therefore, if signing as a mediator is to have practical utility then visual inspection of the data will reveal the effect.

This thesis is an example of applied behavior analysis and a comment needs to be made regarding the role of theory. The goal of applied behavior analysis is to examine the controlling variables for socially important behaviors (Baer et al, 1968). The method used to achieve this goal has stressed an inductive, fact finding approach instead of the more traditional hypothetico-deductive model of scientific research (Sidman, 1960; Skinner, 1953). In the typical applied behavior analysis study an explicit theory from which a hypothesis is derived and tested is absent. This is not to be interpreted as a rejection of the use of theory in science. Skinner (1950) accepts theory as useful but argues that it is not always <u>necessary</u> for a science of behavior.

Practically speaking however, many investigators within the applied behavior analysis model do hold expectations (hypotheses), although not necessarily derived from theory, as to what their experimental manipulations will yield. Sidman (1960, p. 10) advises investigators to "hold their hypotheses lightly" so that they would be open to any new and unexpected observations. Since the area under present investigation is largely unexplored and lacking in theory the hypotheses previously presented must be accepted with Sidman's advice in mind.

Method

Subjects

Four children, all nonverbal at the beginning of the experiment, participated in the study. They were selected from those children being trained in the use of sign language at the Autistic Children's Unit of the M. F. McHugh School in Ottawa. All the children had been diagnosed as autistic. Their chronological ages ranged from 11 years, 3 months to 16 years, 10 months with intellectual functioning levels not exceeding an IQ of 88.

These children had been exposed to verbal training programs which met with poor results (Wheeler, Watters, & Watters, Note 4). This was followed by a more successful program with training in American Sign Language (ASL). At the onset of the study sign vocabularies for these children, as estimated by their teachers, ranged from 80 to 400 words (both receptive and expressive). Table 1 documents the relevant characteristics of the four children who participated in the study. The description of the subjects provided here is intended only to provide the reader with a "feel" for the children and not to make a specific statement about autism or intelligence per se. The subject characteristics addressed by this theis is defined in part 1 of the experiments.

During the execution of this study the children periodically displayed inappropriate behaviors. They

Table 1

Characteristics of the Children

Name	Sex	CA	IQ[a]	Diagnosis	Sign Vocabulary
Mark	M	12-10	47	autistic	80
Ned	M	11-3	45	autistic	80
Alice	F	16-10	88	autistic	275
Kim	F	13-9	10[b]	autistic	400

Note. CA (chronological age) is given in years and months.

[a]Performance IQ of WISC-R (administered 1976).

[b]Peabody Picture Vocabulary Test (administered 1976).

also showed individual preferences for different reinforcers. Kim and Alice were the least disruptive of the four children and they were usually attentive and cooperative with the experimenter. Social reinforcement was used for both Kim and Alice. This reinforcement often consisted of saying "Good" or a pat on the shoulder was given upon the occurrence of desired behavior.

Ned was a more disruptive child. He frequently exhibited inappropriate behavior consisting of sudden outbursts of high pitched screams and leaving the table. However, Ned usually complied with instructions from the experimenter to stop the high pitched vocalizations and to return to the table. Candy served as reinforcement for Ned.

The most difficult child to control was Mark. At the time of the study Mark displayed a wide range of inappropriate behaviors. These behaviors ranged from leaving the table to self-mutilating behaviors (e.g., biting and scratching). At times it was necessary to physically restrain Mark from leaving the table or from injuring himself. Appropriate behavior from Mark was reinforced by administering tokens. After five tokens were collected the tokens were then exchanged for cookies or other foods.

Stimulus Materials

Ten words were used in this study (tree, dog, house, shoes, hat, chair, light, car, coat and eyeglasses). Each picture was represented by a picture of the object, the auditory name of the object and the sign language name of the object. All words were known to the children. That is, given the word in sign form, the child could select the appropriate picture from an array of pictures (receptive) and given the picture, the child could produce the appropriate sign (expressive). Initial selection was based upon the teacher's report of the child's mastery of these skills, but as indicated later, this reported performance was checked during the first part of each experiment. In all cases the teacher's report proved to be accurate. Five of the words were used in Experiment 1 and the remaining five were used in Experiment 2.

Pictures. Picture stimuli were presented on cards made from a mauve colored construction paper. The cards measured 12 cm. X 12 cm. with the stimulus itself presented within a square measuring 5 cm. X 5 cm. centred on the card. The picture stimuli were line drawings chosen in

consultation with the teachers and were the same size, within practical limits.

For each of the five words that were used in Experiment 1, there were two visually distinct pictures for a total of ten different pictures. In addition, there was a duplicate of each of the ten different pictures for a total of 20 picture cards. For Experiment 1, the two visually distinct picture sets were labelled Set 3 and Set 4.

The two visually distinct pictures for each word and the duplicate set of pictures allowed for identity and nonidentity matching. In identity matching the sample stimulus and the correct choice stimulus were visually identical pictures (e.g., the sample might be a picture of a man's shoe and the correct choice stimulus would be an identical picture of a man's shoe). For the nonidentity matching task the sample and the correct choice, while representing the same word, were not visually identical (e.g., the sample might be a picture of a man's shoe and the correct choice would be a picture of a woman's shoe). The pictures for nonidentity matching formed Set N which was a combination of Set 3 and Set 4.

In Experiment 2, each of the five words were

represented by two visually distinct pictures for a total of ten different pictures, but there were no duplicates of these pictures. These two visually distinct picture sets were labelled Set 1 and Set 2.

Signs. ASL is a nonverbal, gestural form of communication and is widely used in communicating with the deaf (Reikehof, 1963). For each word used in the study there was a corresponding sign. That is, there were ten distinct signs, five corresponding to the words used in Experiment 1 and five corresponding to the words used in Experiment 2.

Auditory. Each word could be presented in auditory form (said by the experimenter). This auditory form was used for each of the five words in Experiment 2.

General Testing Procedures

A test session was comprised of 20 trials although there was some variation in the length of the session as a function of the specific task being examined and as a function of the child's on task performance on any particular day. Each of the five stimuli were presented a minimum of four times during each session with no two adjacent trials having the same sample stimulus. All sample and choice stimuli were selected and

presented in a random, counterbalanced order (Gellermann, 1933). All children were tested in their school rooms at a long table set aside from the main group of students. The experimenter sat opposite the child.

The table was marked with a pencil to facilitate the positioning of the choice stimuli. The choice stimuli were placed in the cornor of the table nearest the child. They were laid out, side by side, 15 cm. from the edge of the table nearest the child and 15 cm. from the edge of the table perpendicular to the child and the experimenter.

A sheet of fiberboard (23 cm. X 75 cm.) was used to fulfill two functions. First, it aided the experimenter by providing a standard placement of the sample stimulus. On the fiberboard was centred a 12.5 cm. X 12.5 cm. penciled square. On this penciled square was placed the sample stimulus card for all trials. Second, the fiberboard served as a screen for covering the choice stimuli during the matching-to-sample tasks.

Each trial began by establishing eye contact with the child and by positioning the child's hands in a ready position (hands directly in front of himself on the table). For the matching tasks

the choice cards were laid out behind the fiberboard. Then the fiberboard was placed on top of the choice stimuli completely covering them and the sample stimulus was placed on the fiberboard within the penciled square.

In the simultaneous matching-to-sample condition, the fiberboard was moved back towards the experimenter and aligned to the tops of the choice stimuli after the child touched the sample stimulus. In the delayed matching-to-sample condition, the choice stimuli were not exposed until the end of a pre-determined delay interval. During the removal of the fiberboard from the choice stimuli, the sample stimulus remained in the same position for the simultaneous matching-to-sample tasks. In the delayed matching tasks, the sample stimulus was completely removed from sight and placed under the table.

For all tasks, correct choices were reinforced with whatever reinforcer was most effective for the child (candy, praise, etc.). This reinforcer was determined in consultation with the teacher. Incorrect responses had no programmed consequences, that is, a noncorrection procedure was followed.

Five basic procedures were employed: 1) simultaneous matching-to-sample (M-T-S), 2) delayed

matching-to-sample (D-M-T-S), 3) titration, 4) naming by signing and 5) the assessment of generalization. The M-T-S, D-M-T-S and naming by signing procedures are summarized in Table 2.

Simultaneous Matching-to-Sample

Picture-picture matching. Given a picture sample, the experimenter instructed the child, "Look at this and touch it". Instructions and prompts were given in simultaneous communication. That is, they were said as well as signed. After the child touched the sample stimulus the screen covering the choice stimuli were removed. The sample picture remained exposed and the child was then told, "Give me the same". Although the children were instructed to give the correct picture to the experimenter, simply touching the picture was considered sufficient to be recorded as a response. This was in keeping with the practise established by the teachers. Correct choices were reinforced, incorrect choices had no programmed consequences.

Table 2

Description of Procedures

Task	Sample Stimulus	Response required to expose choices	Delay	Choice	Response required to end trial
Simultaneous picture-picture M-T-S.	picture	touch sample picture	no	pictures	touch a choice stimulus
Simultaneous sign-picture M-T-S.	experimenter signs name of correct choice	touch blank sample card	no	pictures	touch a choice stimulus
Simultaneous auditory-picture M-T-S	experimenter says name of correct choice	touch blank sample card	no	pictures	touch a choice stimulus
Delayed picture-picture M-T-S.	picture	touch sample picture	yes	pictures	touch a choice stimulus
Delayed sign-picture M-T-S	experimenter signs name of correct choice	touch blank sample card	yes	pictures	touch a choice stimulus
Delayed auditory-picture M-T-S.	experimenter says name of correct choice	touch blank sample card	yes	pictures	touch a choice stimulus
Naming a picture by signing	picture	not applicable	no	not applicable	sign appropriate word
Naming an auditory stimulus by signing	experimenter says word	not applicable	no	not applicable	sign appropriate word

Sign-picture matching. The experimenter signed and said to the child, "Look at me", and then signed the word. This was followed by the instruction, in simultaneous communication, to touch the blank sample card. After the child touched the blank sample card, the screen was removed exposing the choice stimuli. The child was to touch the picture from the five choices presented which corresponded to the sign.

The experimenter repeated the sign every two seconds until the child made his choice. Correct choices were reinforced and incorrect choices had no programmed consequences. If the child touched the sample without having looked at the experimenter's signing of the word, the choice stimuli remained covered. The experimenter then attempted to direct the child's attention to the signed word. This was achieved by repeating the instructions or physically guiding the child's face to ensure that the signing of the word would be within his field of vision.

Auditory-picture matching. The experimenter said the word (sample) followed by the instruction in simultaneous communication, "Give me name of sample" (the name of the sample was said only). The child was required to choose the corresponding

picture from the five choices presented. The experimenter repeated the word name every two seconds until a choice was made. Correct choices were reinforced and incorrect choices had no programmed consequences.

Delayed Matching-to-Sample

This procedure was basically the same as the simultaneous matching-to-sample procedure except for the introduction of a delay before the exposure of the choice stimuli. The length of the delay and its determination is described in the Titration procedure. The specific matching tasks (picture-picture, sign-picture and auditory-picture) remained the same as in the simultaneous matching-to-sample except for a few modifications. Only the modifications are now described.

Picture-picture matching. The picture sample was removed from sight (placed under the table) when the child touched it and the delay interval began. At the end of the delay interval the choice pictures were exposed.

Sign-picture matching. The experimenter stopped signing the word when the child touched the blank sample card. At that point the blank

card was removed and the delay interval started. At the end of the delay interval the choice stimuli were exposed.

Auditory-picture matching. Once the child touched the blank sample card the experimenter stopped saying the word and the blank card was removed. The delay interval began with the removal of the blank sample card and was ended with the presentation of the choice stimuli.

Titration

The delayed matching-to-sample procedure was modified by varying, in a systematic fashion, the delay between the removal of the sample stimulus and the exposure of the choice stimuli. The first trial, at zero delay, consisted of the child touching the sample stimulus whereupon the sample and the fiberboard covering the choices were removed allowing the child to respond. On the next trial, provided the child responded correctly at zero delay, the exposure of the choice stimuli was delayed one second. That is, immediately following the child touching the sample card, it was removed and one second later the choice cards were exposed.

Correct choices had, then, two consequences: reinforcement and an increase in the delay interval by one second on the next trial. As long as the child continued to respond correctly the delay interval was increased by one second with each successive trial. An incorrect response was followed by a one second decrement in delay on the next trial. These decrements continued until the child once again made a correct choice whereupon the cycle was repeated. After a few of these cycles a delay interval was found where the child responded on a random basis over the last 20 trials (random responding with five choice cards would result in performance at the chance level of 20%).

It was quite often the case that an adequate assessment of performance at chance level was not practical because of restrictions imposed by the titration procedure itself. Since failure on any given trial at a delay interval dictated a return to a shorter delay interval on the next trial, the number of trials a child was exposed to at the longer delay intervals was restricted. Although it was possible to determine a delay interval at which the child consistently performed at a 20%

level of accuracy, the number of trials and sessions required would have been prohibitively high. Therefore, matching accuracies less than 35% were judged to be sufficiently close to random or chance level responding for the purposes of this study.

By this method of titration or self-adjusting schedule of delays (Scheckel, 1965) a "terminal delay interval" was determined for picture-picture and auditory-picture delayed matching tasks. This was the delay interval which produced accuracies between 20% and 35%.

To test for the possible effects of impulsive responding as reported by Lowry and Ross (1975), the children were also tested at a delay interval five seconds longer than the terminal delay interval. Each child was presented with a block of ten trials composed of seven trials with short delays and three randomly interspersed trials at the child's terminal delay interval. The short delays consisted of trials with one and two second delays which typically resulted in high performance levels. During the three trials at the terminal delay interval the child was prevented from responding (hands were held by the experimenter) for an

additional five seconds although all the stimuli remained in full view. If the child's performance improved, the titration procedure was re-introduced and a new terminal delay interval was determined. A re-introduction of the titration procedure following the test for impulsive responding was never required.

The whole titration procedure, including the test for the effects of impulsive responding, was repeated on a second day. The average of these two determinations was the terminal delay interval that was used in part 2 of the experiments. If the terminal delay interval found on the second day deviated greatly from that found on the first day, baseline was extended with further repetition of the titration procedure until a stable delay interval was found. A difference of three or more seconds between the two determinations was considered great enough to warrant the continuation of the titration procedure on the next day.

Naming by Signing

This procedure involved the presentation of a sample stimulus whereupon the child was required to produce the appropriate sign. When the sample

stimulus was a picture, the child was asked in simultaneous communication, "What is it?". When the sample was auditory, the child was instructed, "Sign sample". Correct responses were reinforced and incorrect responses had no programmed consequences. After the intertrial interval of not less than ten seconds, the next stimulus was presented in the same manner.

Assessment of Generalization

Stimulus materials. Ten words (scissors, table, mitten, key, cup, cat, spoon, ball, apple and telephone) were used to assess generalization. These were words not used previously, but known by the children according to the same criteria that were used for the selection of the other words in the study. Each word was represented by a picture of the object, an oral form and a sign language form. The characteristics of the pictures were the same as those described earlier (see Stimulus materials-pictures). Five of the words were used in Experiment 1 and the remaining five words were used in Experiment 2.

Procedure. The generalization tests were completed in an empty classroom with only the

experimenter and the child present (except for reliability trials). The choice pictures were laid on a table and shielded from view by the same fiberboard which was described previously. The fiberboard was held upright by a wooden base. The fiberboard remained in an upright position throughout the generalization test. The choice pictures could only be seen if one was directly in front of the fiberboard and looking over it.

The trial began with the child sitting in a chair placed at the opposite end of the room from where the choice pictures were positioned. In the generalization test for Experiment 1, the experimenter presented to the child a picture as the sample stimulus. The child was required to touch the sample picture after which he was escorted by the experimenter to the opposite side of the room where the five choice pictures were placed. The child was then required to select the picture which matched the sample picture shown. The only instruction given was, "Give me the same", which was delivered in simultaneous communication during the presentation of the sample stimulus. Correct choices were reinforced and incorrect choices had no programmed consequences.

For Experiment 2, the generalization test remained the same except for three modifications. First, the sample was oral; the experimenter saying, "Give me sample name", without signing. Second, since the sample stimulus was presented orally, the child was required to touch a blank card before preceeding to the choice stimuli. Finally, as mentioned previously, the stimuli were five new words. Once again, correct choices were reinforced and incorrect choices had no programmed consequences.

The sample stimuli were presented in a random order and each stimulus was presented three times. Thus, a total of 15 trials comprised each session. The choice stimuli were mixed after each trial during the intertrial interval of one minute. Only identity matching was required.

The accuracy of each response and the time it took the child to cross the room and make his choice were recorded during the intertrial interval. The timing of the delay interval began when the child touched the sample stimulus card (which was either a picture or a blank) and ended when the child touched the choice picture.

After completion of the generalization test, the child was returned to his home room and required to complete a number of tasks with the generalization set of words to ensure that he had the component skills necessary to do the generalization test. This involoved a number of simultaneous matching-to-sample tasks. Depending upon the experiment, the child was required to complete ten trials of picture-picture M-T-S (Experiment 1) or ten trials of auditory-picture M-T-S (Experiment 2). In addition, ten trials of sign-picture M-T-S and five trials of naming by signing were conducted. If either matching accuracy or correct naming in any of the tasks were below 100%, then new stimuli were selected and another generalization test was conducted. The selection of new stimuli and a repetition of the generalization test was never required.

Reliability

Reliability was assessed for a sample of trials which were selected depending upon the availability of a teacher. The teacher was asked to observe a session and record the child's response to each trial. The observer's recorded responses

were compared to the experimenter's recorded responses. A percentage of agreement was derived from the ratio of the number of matched recorded responses to the total number of trials observed multiplied by 100. The following conditions were assessed for reliability: picture-picture D-M-T-S, auditory-picture D-M-T-S, generalization test, sign-picture D-M-T-S and naming by signing. A total of 109 trials were rated with a minimum of ten trials in any one condition. Four teachers participated as observers. The percentage of agreement on these 109 trials was 100 per cent.

EXPERIMENT 1

The purpose of part 1 of Experiment 1 was to determine whether or not any of the children exhibited a sign production deficiency when the stimulus was presented visually. To meet the conditions for a sign production deficiency, the child had to: 1) perform poorly in the picture-picture D-M-T-S task, 2) perform well in the simultaneous picture-picture matching task, the simultaneous sign-picture matching task and the sign-picture D-M-T-S task and 3) be able to "name" all the pictures by producing the appropriate sign. Only those children exhibiting a sign production deficiency were then exposed to the treatment strategy (part 2 of Experiment 1).

Procedure

Three children (Ned, Kim and Alice) began with Experiment 1 followed by Experiment 2. Mark received the reverse order.

Part 1. Assessment of Performance

Performance was assessed on a number of matching tasks and the naming by signing task. The criteria for success in the simultaneous matching task was 90% (18 correct matches in the last 20 trials) and for

the naming by signing task it was also 90% (18 correctly signed pictures on the last 20 trials). Following the day criterion was reached on a task the child was exposed to a new task. The criteria for completion of the D-M-T-S task was described previously (see Titration).

The order of the tasks and the procedures were as follows:

(i) The child's matching accuracy on the picture-picture simultaneous M-T-S task was assessed.

(ii) Using the titration procedure, the terminal delay interval was determined for the picture-picture D-M-T-S task and consequently matching accuracy on the picture-picture D-M-T-S task was assessed with a delay interval equal to the terminal delay interval.

(iii) The child's matching accuracy on the sign-picture simultaneous M-T-S task was assessed.

(iv) Using the terminal delay interval determined in (ii), the child's matching accuracy on the sign-picture D-M-T-S task was assessed.

(v) Using a picture sample, the child's performance on the naming by signing task was assessed.

(vi) To control for the possibility that exposure to the tasks outlined in (ii), (iv) and (v) may had effected the terminal delay interval determined in (ii), the titration procedure was repeated for the picture-picture D-M-T-S task.

Generalization pre-test. Performance was assessed on the generalization test involving picture-picture D-M-T-S.

Part 2. Treatment: Signing the Sample Picture

Over a series of sessions children who performed poorly on the picture-picture D-M-T-S task, as assessed in part 1, were then provided with a strategy to help them bridge the delay in the picture-picture D-M-T-S task. Each session was composed of two distinct sets of trials. The first ten to fifteen trials (prompted trials) required the child to produce the appropriate sign (naming by signing) when presented with the picture sample. Only after the sign was produced did touching the sample result in removal of the sample and the initiation of the delay interval which ended with the exposure of the choice pictures. The session ended with a block of

ten trials (unprompted trials) which did not require the child to produce the appropriate sign before touching the sample resulted in removal of the sample stimulus and the initiation of the delay interval. A more detailed description of these two blocks of trials and the procedures involved follows.

Prompted trials. The first set of trials within a session assessed performance on the picture-picture D-M-T-S by using the titration procedure. The mechanics of the procedure remained unaffected except for the introduction of a new variable, signing the picture. The presentation of the sample picture was accompanied by the instruction, "What is it?", given in simultaneous communication. This usually elicited the appropriate sign from the child followed by touching the sample picture and the initiation of the delay interval. In addition, correct signing by the child was reinforced. Upon exposure of the choice pictures at the end of the delay, the child was required to touch the choice picture which matched the sample picture. A correct choice was reinforced. Incorrect choices had no programmed consequences.

Failure by the child to produce the appropriate sign in the presence of the sample picture led to explicit training by the experimenter. If necessary the child's hands were moulded into the proper sign configuration. Completion of a sign by the child, by whatever means, was followed by reinforcement. Over trials the prompts were systematically faded in order to maintain high performance levels without the aid of prompts. This fading was implemented by gradually decreasing the amount of physical direction provided by the experimenter. For example, hand moulding was reduced to a nudge of the child's hand to a simple hand gesture from the experimenter without any physical contact. This was accomplished in small, gradual steps to ensure a high probability of success. In all cases, when the child did produce the sign, it was produced only once. The hands always returned to a relaxed position and never remained in any specific sign configuration during the delay interval.

The use of the titration procedure for the prompted trials allowed for the determination of a new terminal delay interval, as well as the assessment of performance at the terminal delay

interval determined in part 1, under the new condition of the sample picture being signed by the child. The pictures used were the same as those in part 1.

Unprompted trials. The unprompted trials were intended to assess the occurence of signing in the presence of the sample and in the absence of direct prompting by the experimenter.

The task involved picture-picture D-M-T-S. However, during these unprompted trials the instruction, "What is it?", did not accompany the presentation of the sample picture. The only response required by the child was to touch the sample picture. This resulted in removal of the sample and the start of the delay interval which ended with the exposure of the choice pictures. That is, no prompt, either physical or verbal, was given by the experimenter. All trials were at the terminal delay interval determined in part 1.

During these unprompted trials response choice and spontaneous signing were recorded. Spontaneous signing by the child received no programmed consequences. However, correct matches were followed by reinforcement.

For all the children there were a number of trials during the unprompted trials, when the child

did not sign. From the treatment sessions there was then performance on the trials when the child signed (some prompted and some unprompted) and performance on trials when the child did not sign. Thus, a within session A-B (baseline-treatment) comparison could be made. In this manner the control of signing over delayed matching behavior could be demonstrated on a daily basis. However, for the sake of simplicity the data was presented collapsed over sessions. Performance during part 1 of the experiment (without signing) and the prompted trials in part 2 (with signing) allowed for a between session comparison.

All the children began with the first set of pictures and did not move on to the next set of pictures until a criterion was met. The criterion consisted of eight signings of the sample stimulus during the ten unprompted trials. Once this criterion was met, the child was exposed to the next stimulus set on the following day. After the criterion was reached on the three sets of pictures (Sets 1, 2 and N) the child was exposed to a generalization post-test.

Generalization post-test. This session occurred the day following completion of part 2. Performance was assessed on the generalization test involving picture-picture D-M-T-S.

Results

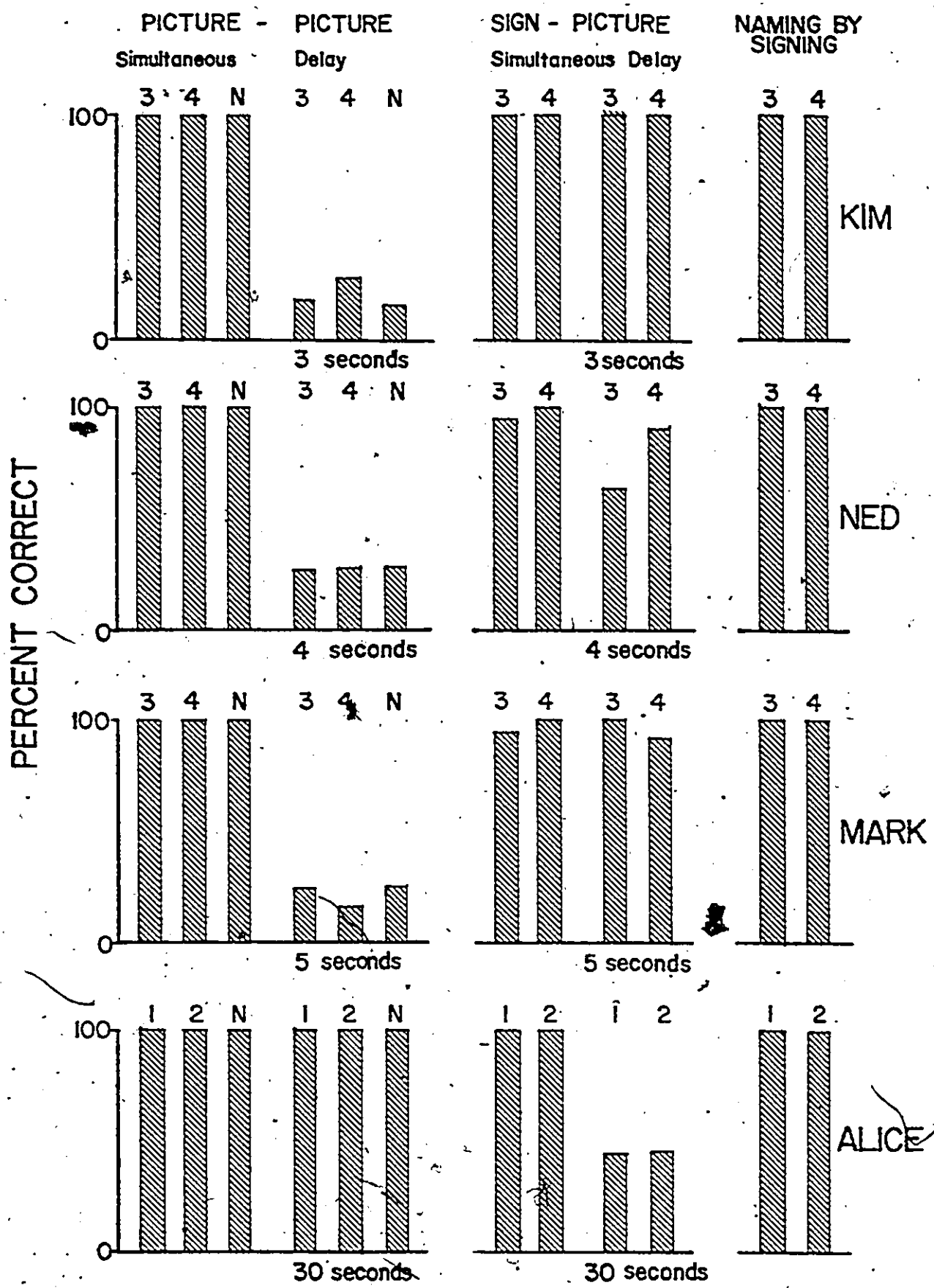
Part 1. Assessment of Performance

The percentage of correct matches on the simultaneous and delayed matching tasks, as well as performance on the naming by signing task, are presented in Figure 1. Performance on the picture-picture tasks is presented along the left side of the figure, performance on the sign-picture tasks is presented in the centre of the figure, and performance on the naming by signing task is presented along the right side of Figure 1.

Each bar for the simultaneous picture-picture M-T-S task, the simultaneous sign-picture M-T-S task and the naming by signing task was based upon 20 trials. Each bar for the picture-picture D-M-T-S task was based upon from 11 to 24 trials and each bar for the sign-picture D-M-T-S task was based upon from 7 to 51 trials.

All but one of the children met the requirements for participation in part 2 of Experiment 1. Alice failed to demonstrate a production deficiency. She matched the pictures accurately at 30 second delay intervals and continued to perform above chance levels (66%) at 90 second delay intervals. Only

Figure 1. Performance on Matching and Naming by Signing Tasks for Part 1, Experiment 1.



Note. Stimulus set used appears above the bars. N= nonidentity set. Terminal delay intervals appear beneath delay scores.

performance at the 30 second delay interval is reported for the matching tasks since a large number of trials at longer delays would have produced uncooperative behavior from Alice. In addition, Alice's performance on the sign-picture D-M-T-S task failed to reach the same level of accuracy as on the picture-picture D-M-T-S task. Since one of the criteria for a production deficiency was better performance on the sign-picture D-M-T-S task as compared to the picture-picture D-M-T-S task, Alice did not participate in part 2 of Experiment 1.

Kim, Ned and Mark demonstrated production deficiencies. Performance on the simultaneous matching tasks were near perfect levels (95 to 100%). However, matching accuracies at the terminal delay intervals on the picture-picture D-M-T-S tasks neared chance level (20%) and ranged from 17 to 29 percent. The terminal delay intervals varied within a narrow range, three to five seconds. Performances on the other tasks were considerably higher. The accuracy of matching responses on the sign-picture D-M-T-S tasks ranged from 62% to 100%). All the children could name the pictures by signing. Neither identity nor nonidentity matching appeared to have a differential effect upon performance.

To assess for the possibility that the children were responding impulsively, as defined by Lowry and Ross (1975), which in turn would have presented a false impression of the terminal delay intervals determined for each child, the children were prevented from responding to the exposed comparison stimuli for an additional five seconds on randomly selected trials. The results of this manipulation, for the children who exhibited a production deficiency, are shown in Table 3. Alice was not exposed to this manipulation since, as indicated earlier, her performance made her unsuited for the second part of Experiment 1. The percentages presented in Table 3 for the "Delay + 5 seconds" are based upon a minimum of 10 trials.

In Table 3 each child's performance at his/her terminal delay interval is compared under two conditions, with a five second delay preventing responses to the exposed choice pictures and without the prevention of responses. If the children were responding in a manner similar to the children in the Lowry and Ross (1975) study, imposing a delay between the exposure of the choice stimuli and the opportunity to respond, should improve performance. This was not found. For the children in this experiment, performance on the picture-picture D-M-T-S task did not appear to be the result of impulsive responding to the choice stimuli.

Table 3

Percentage of Correct Matches With and Without an Additional Five Second Delay Beyond the Terminal Delay Interval: Experiment 1, Part 1

	Picture-picture D-M-T-S	
	Delay	Delay + 5
Kim		
3	19	38
4	28	20
N	17	33
Ned		
3	28	32
4	29	25
N	29	30
Mark		
3	27	31
4	14	14
N	27	33

Note. The stimulus set used appears below and to the right of the child's name. Percentages given are for matching accuracy at the terminal delay interval (Delay) and the terminal delay interval plus five seconds (Delay + 5). A randomization test for matched pairs (Siegel, 1956) revealed no significant differences between the two conditions.

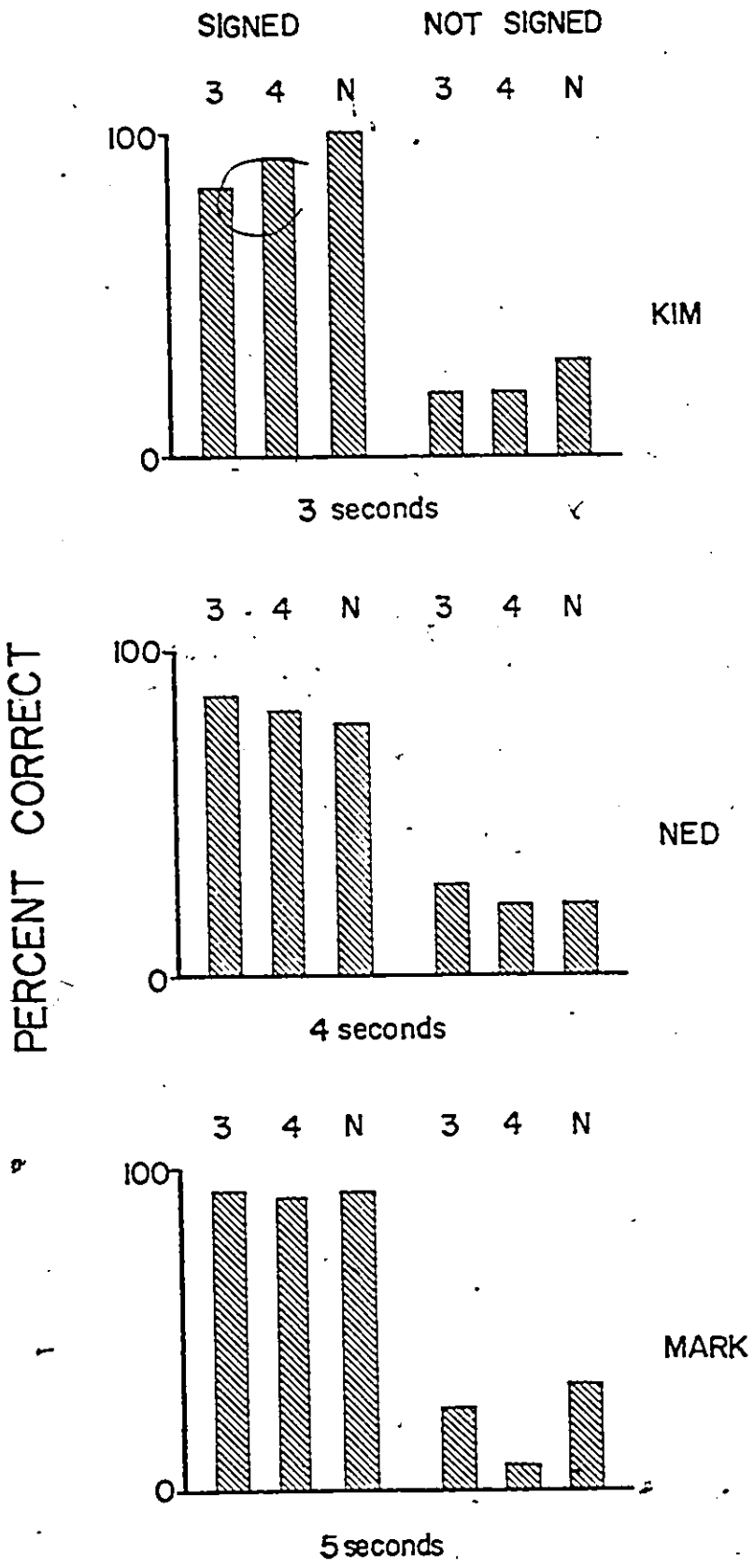
Part 2. Treatment: Signing the Sample Picture

Given a production deficiency, part 2 of Experiment 1 evaluated a strategy for improving performance on a picture-picture delayed matching task. The children were taught to produce the appropriate sign in the presence of the sample stimulus before the delay interval was imposed. Figure 2 illustrates the effects of this strategy. Performance at the terminal delay interval was compared under two conditions: 1) signing the sample and 2) not signing the sample. Each bar in the figure represents, for the not signed condition a minimum of 9 trials to a maximum of 14 trials and, for the signed condition, a minimum of 14 trials to a maximum of 25 trials. The bars are based upon trials completed during the treatment sessions only (part 2, Experiment 1).

Clearly, this strategy was effective for all the children who exhibited a production deficiency. When the child was required to sign the sample, matching accuracy improved from near chance levels (9% to 33%) to a minimum of 79% correct matches (Ned, Set N) and a maximum of 100% correct matches (Kim, Set 4).

Improved matching accuracy could also be observed across delay intervals other than the terminal delay interval. Data drawn from part 1, Experiment 1 (signing

Figure 2. Percentage of Correct Matches on Picture-Picture D-M-T-S With and Without Signing for Part 1, Experiment 1.



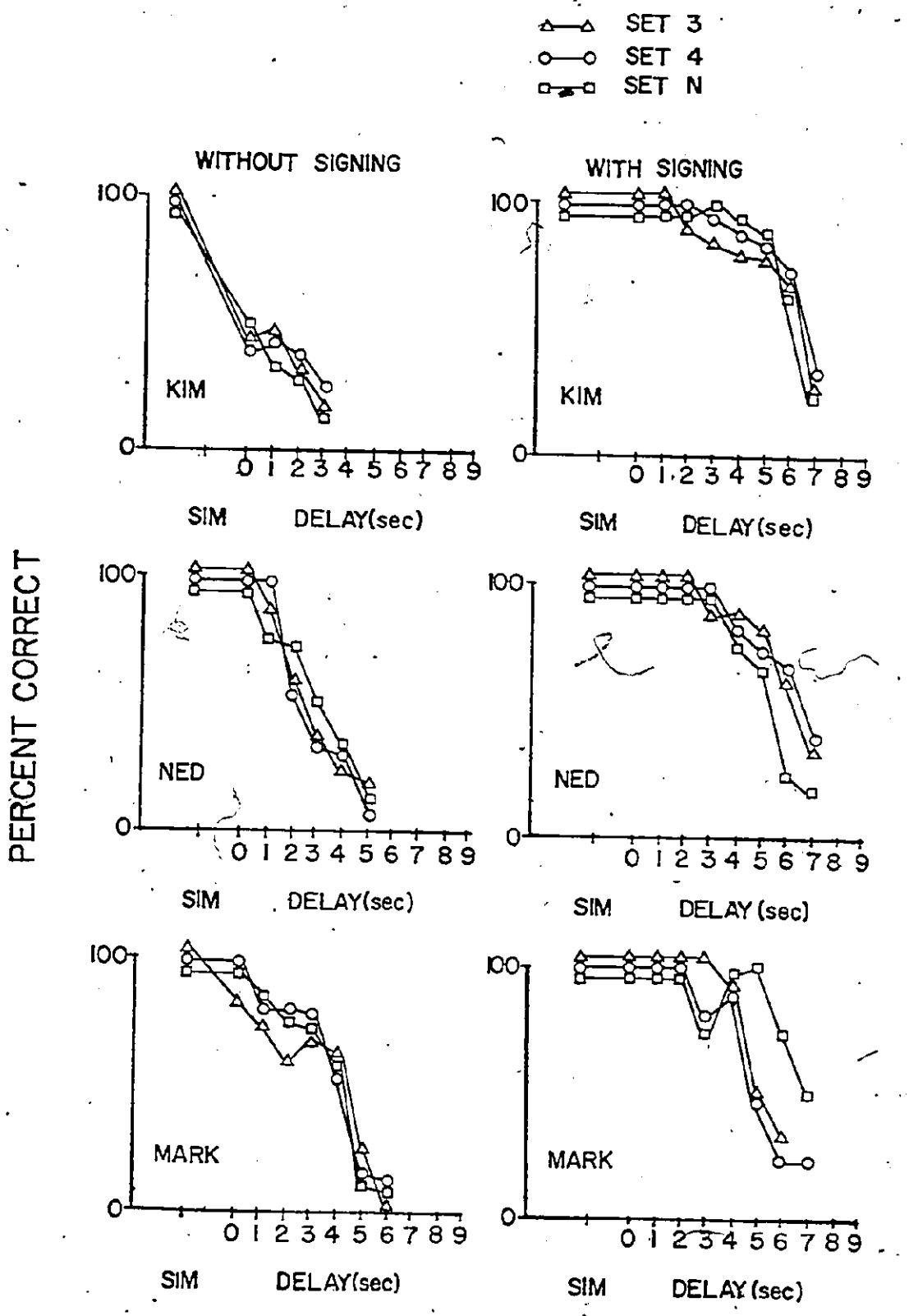
Note. Trials are from the treatment sessions only. The stimulus set used appears above the bars. N= nonidentity set. Terminal delay intervals for each child appear below the abscissa.

not required) was compared with data from part 2 of the experiment for those trials when signing was required. Figure 3 presents the resulting recall curves. Data points are based upon a minimum of nine trials at each delay interval. When the child responded by signing in the presence of the sample, the recall curve was shifted towards longer delay intervals. When the child signed the sample stimulus, matching accuracy did not approach chance levels until the delay interval was seven seconds. This was observed for all children. For Kim, this was a difference of four seconds when compared to her performance in the first part of the experiment. Similarly, for Ned the difference was three seconds and for Mark, the difference was two seconds.

The percentage of correct matches and percentage of spontaneously signed trials made on the generalization tests are presented along a three dimensional space in Figure 4. Performance for both of these variables before and after treatment are shown.

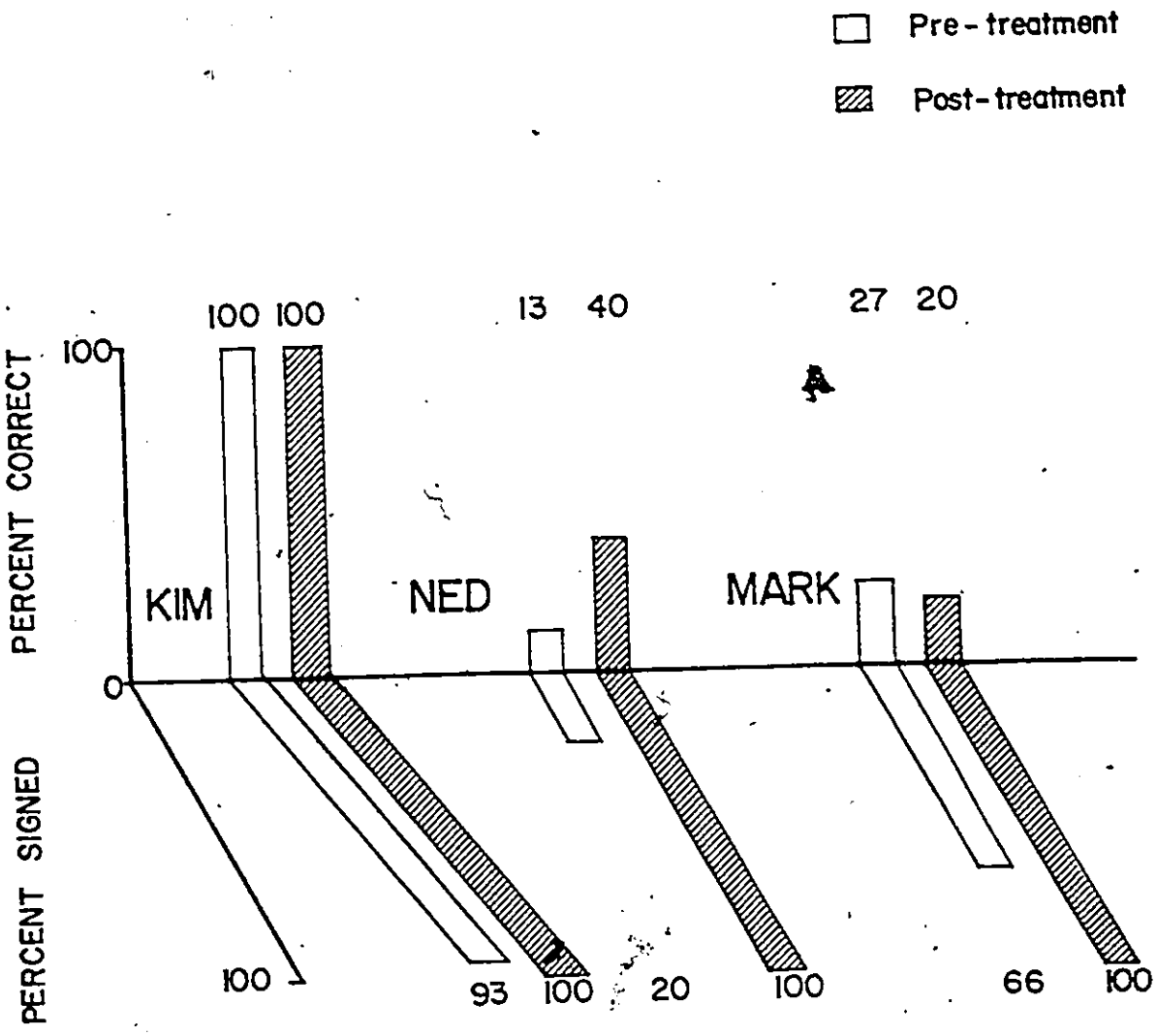
In terms of matching accuracy, no consistent difference was noted before or after treatment. Kim was already performing at 100% accuracy on the generalization test before treatment while Ned and Mark demonstrated changes in the reverse direction. Table 4 presents the mean delay intervals along with

Figure 3. Percentage of Correct Matches on Picture-Picture D-M-T-S Across Delay Intervals for Experiment 1.



Note. Recall curves for without signing condition are based upon data from part 1, Experiment 1. Recall curves in the signing condition are based upon data from part 2 of Experiment 1. SIM= simultaneous.

Figure 4. Percentage of Correct Matches and Spontaneously Signed Trials on Generalization Tests for Experiment 1.



Note. The exact percentages are given above and below the appropriate bars. The sample stimuli were pictures.

Table 4

Delay Intervals (Sec.) for the Generalization Tests in Experiment 1

	Kim		Ned		Mark	
	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
Pretest	10.0	2.3	15.1	7.7	11.2	5.5
Post-test	7.1	1.8	13.5	6.9	12.1	5.3

the standard deviations for all the children on the generalization tests. It should be noted that all the delay intervals were longer than the delay intervals at which better than chance level responding was to be expected.

Consistent changes were observed with respect to spontaneous signing of the sample stimulus. All three children showed an increase in spontaneous signing, signing on all trials, following treatment. This increase was quite dramatic in Ned's case. He went from signing on 20% of the trials before treatment to 100% following treatment.

EXPERIMENT 2

In Experiment 1, three of the children exhibited a sign production deficiency. Furthermore, performance in the delayed matching tasks for pictures improved when production of the appropriate sign in the presence of the sample picture was required. The purpose of Experiment 2 was to assess the effectiveness of the procedure (producing the sign for the sample) when the sample stimulus is presented in the auditory modality.

In part 1 of the second experiment each child was assessed as to whether or not they had a sign production deficiency. The criteria for a sign production deficiency were: 1) poor performance in the auditory-picture D-M-T-S task, 2) good performance in the simultaneous auditory-picture, simultaneous sign-picture and delayed sign-picture tasks, and 3) the ability to produce the appropriate sign in response to orally presented words (i.e., naming by signing). Given a sign production deficiency, part 2 of Experiment 2 assessed the efficacy of the treatment strategy, signing in the presence of the auditory stimulus.

Procedure

Part 1. Assessment of Performance

As in Experiment 1, performance was assessed on

a number of matching tasks and the naming by signing task. However, the sample stimulus in Experiment 2 was presented auditorily instead of visually.

The presentation order of the tasks and the procedures were as follows:

(i) The child's matching accuracy on the simultaneous auditory-picture M-T-S task was assessed.

(ii) Using the titration procedure, the terminal delay interval was determined for the auditory-picture D-M-T-S task. Consequently, matching accuracy on the auditory-picture D-M-T-S task was assessed with a delay interval equal to the terminal delay interval.

(iii) Matching accuracy on the sign-picture simultaneous M-T-S task was assessed.

(iv) Using the terminal delay interval determined in (ii), the child's matching accuracy on the sign-picture D-M-T-S task was assessed.

(v) Using an auditory sample, the child's performance on the naming by signing task was assessed.

(vi) To control for the possibility that exposure to the tasks outlined in (iii), (iv) and (v) may have effected the terminal delay interval determined in (ii), the titration procedure was repeated.

Generalization pre-test. Performance was assessed on the generalization test involving auditory-picture D-M-T-S.

Part 2. Treatment: Signing the Auditory Sample

This phase was similar to part 2 of Experiment 1 in that it assessed the effectiveness of a strategy to help the child bridge the delay in a D-M-T-S task given poor performance on this task. It differed from part 2 of Experiment 1 in that the strategy was applied for poor performance on an auditory-picture D-M-T-S task. Again, each session was composed of trials requiring the signing of the sample (auditory in this case) and trials which did not require signing of the sample stimulus. The procedures for titration and fading of the prompts and the criterion for success remained unaltered. Only the modality of the sample stimulus was changed.

Each trial began with the experimenter saying a word followed by the instruction, delivered in simultaneous communication, "Sign sample". The word was repeated, along with prompts if necessary, until the child produced the appropriate sign. The child was then required to touch a blank sample card and the delay interval began.

All children signed only once on any given trial. They did not sign repeatedly nor did their hands remain in any sign configuration during the delay intervals. Signing in the presence of the auditory sample without

the need of prompts was trained in the same manner described in part 2 of Experiment 1. Criterion levels also remained unaltered.

Generalization post-test. Performance was assessed on the generalization test involving auditory-picture D-M-T-S. This test was completed the day after criterion was achieved on the last two stimulus sets used in the treatment phase of the experiment.

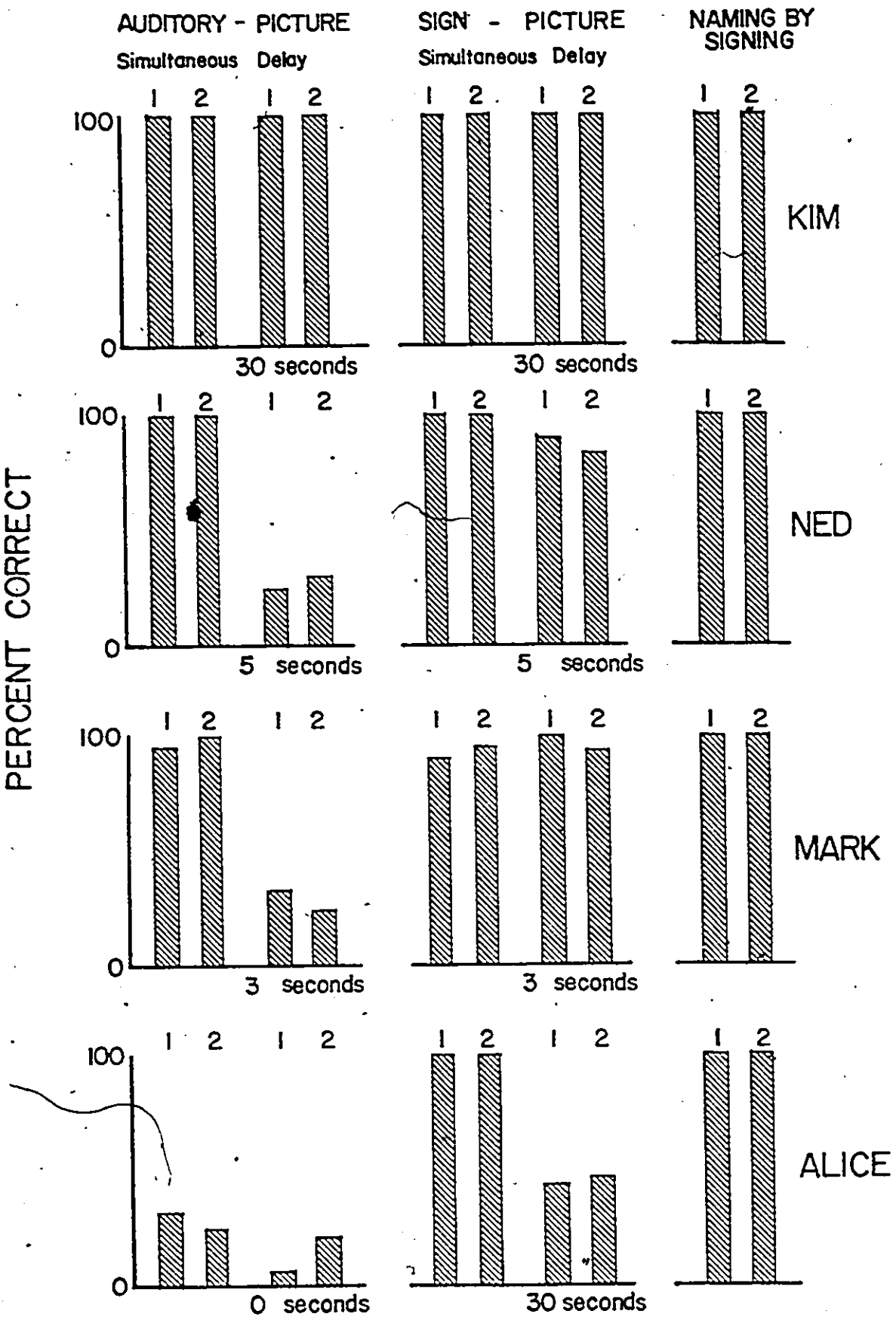
Results

Part 1. Assessment of Performance

Figure 5 illustrates each child's performance on the matching and naming tasks in part 1 of Experiment 2. The graphs are presented in the same manner as in part 1 of Experiment 1 with the major exception being that the picture sample stimulus was replaced by an auditory sample stimulus. Also, a new set of stimuli were used for Kim, Ned and Mark. Alice was exposed to Experiment 1 first and she began with stimulus sets 1 and 2.

Only Ned and Mark demonstrated poor performance on the auditory-picture D-M-T-S task combined with good simultaneous matching and sign-picture delayed matching

Figure 5. Performance on Matching and Naming by Signing Tasks for Part 1, Experiment 2.



Note. Stimulus set used appears above the bars. Terminal delay intervals appear beneath the delay scores.

performances. Their auditory-picture matching accuracies, when tested at their terminal delay intervals, fluctuated near chance levels (25% to 31%). These percentages are based upon 10 to 12 trials at the terminal delay interval for each stimulus set. Each bar for the simultaneous auditory-picture M-T-S task, the sign-picture M-T-S task and the naming by signing task was based upon 20 trials. Each bar for the sign-picture D-M-T-S task was based upon 10 to 15 trials. Note that for the sign-picture D-M-T-S tasks, percentage of correct matches ranged from 83% (Ned, Set 2) to 100% (Mark, Set 1). Additionally, both children were able to produce the appropriate sign for the auditory sample.

In contrast to Ned's and Mark's poor performance on the auditory-picture D-M-T-S task, Kim performed at 100% accuracy at delays up to 30 seconds (based upon 19 trials for Set 1 and 15 trials for Set 2 at 30 second delays). She could not be tested at delays longer than 30 seconds because she became increasingly frustrated when prevented from viewing the choice stimuli for such long delays.

Alice, on the other hand, failed to perform significantly above chance even on the simultaneous auditory-picture matching tasks (15 to 18 trials). Although previous audiological examinations did not report a hearing impairment, Alice continued to perform

on the auditory tasks presented in a functionally deaf manner (this finding of functional deafness was consistent with reports of functional deafness from Alice's teacher). Also, note that when the experimenter presented the sign for Alice (sign-picture D-M-T-S), performance at delays as long as 30 seconds remained above chance levels (51 trials for Set 1 and 49 trials for Set 2).

The results of the tests for impulsive responding are presented in Table 5. Kim and Alice were not tested for impulsive responding since Kim failed to show a deficit in auditory-picture D-M-T-S and could not be used in part 2 and Alice failed to show any discriminating responses to the auditory stimuli and could not be used in part 2. Table 5 compares the percentages of correct matches with and without an added five second delay where the child was prevented from responding although the choice stimuli were exposed. The results indicate that impulsive responding was not a factor that contributed to the child's performance at the terminal delay interval on the auditory-picture D-M-T-S tasks.

Part 2. Treatment: Signing the Auditory Sample

In part 2 of Experiment 2, Ned and Mark were taught to produce the appropriate sign in the presence

Table 5

Percentage of Correct Matches With and Without an Additional Five Second Delay Beyond the Terminal Delay Interval: Experiment 2, Part 1

	Auditory-picture D-M-T-S	
	Delay	Delay + 5
Ned		
1	25	20
2	30	33
Mark		
1	30	33
2	28	25

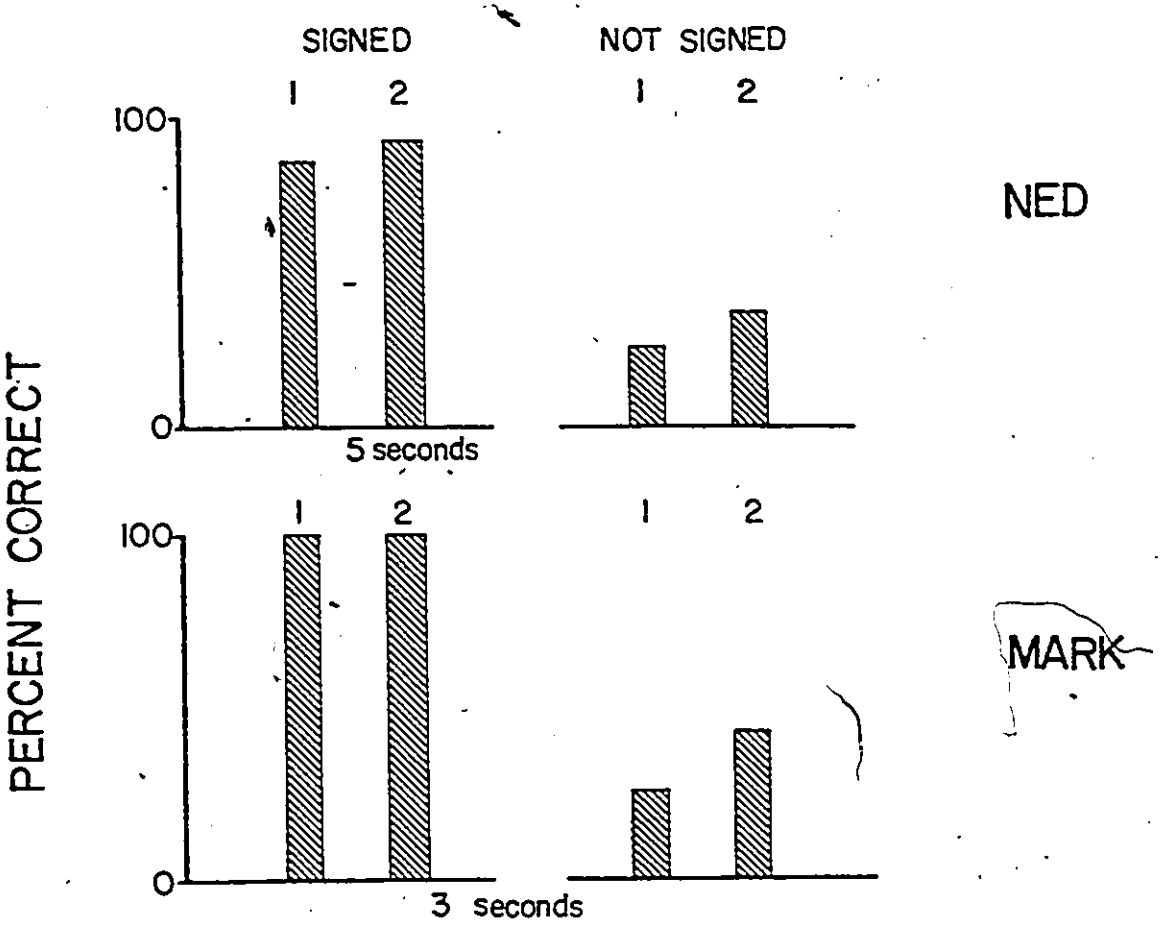
Note. The stimulus set used appears below and to the right of the child's name. Percentages given are for matching accuracy at the terminal delay interval (Delay) and the terminal delay interval plus five seconds (Delay + 5). A randomization test for matched pairs (Siegel, 1956) revealed no significant differences between the two conditions.

of an auditory sample. The results of this manipulation are presented in Figure 6. When Ned and Mark responded to the auditory sample by signing, the percentage of correct matches at the terminal delay interval rose to a minimum of 86% accuracy for Ned and up to 100% accuracy for Mark.

In Figure 6, each bar in the graphs representing performance when the sample stimulus was signed was based upon 9 to 19 trials. When the sample stimulus was not signed in part 2 of the experiment, matching accuracy dropped to between 21% and 43% (each bar was based upon from 9 to 16 trials). These differences in matching accuracy between signed and unsigned trials were observed within the treatment sessions.

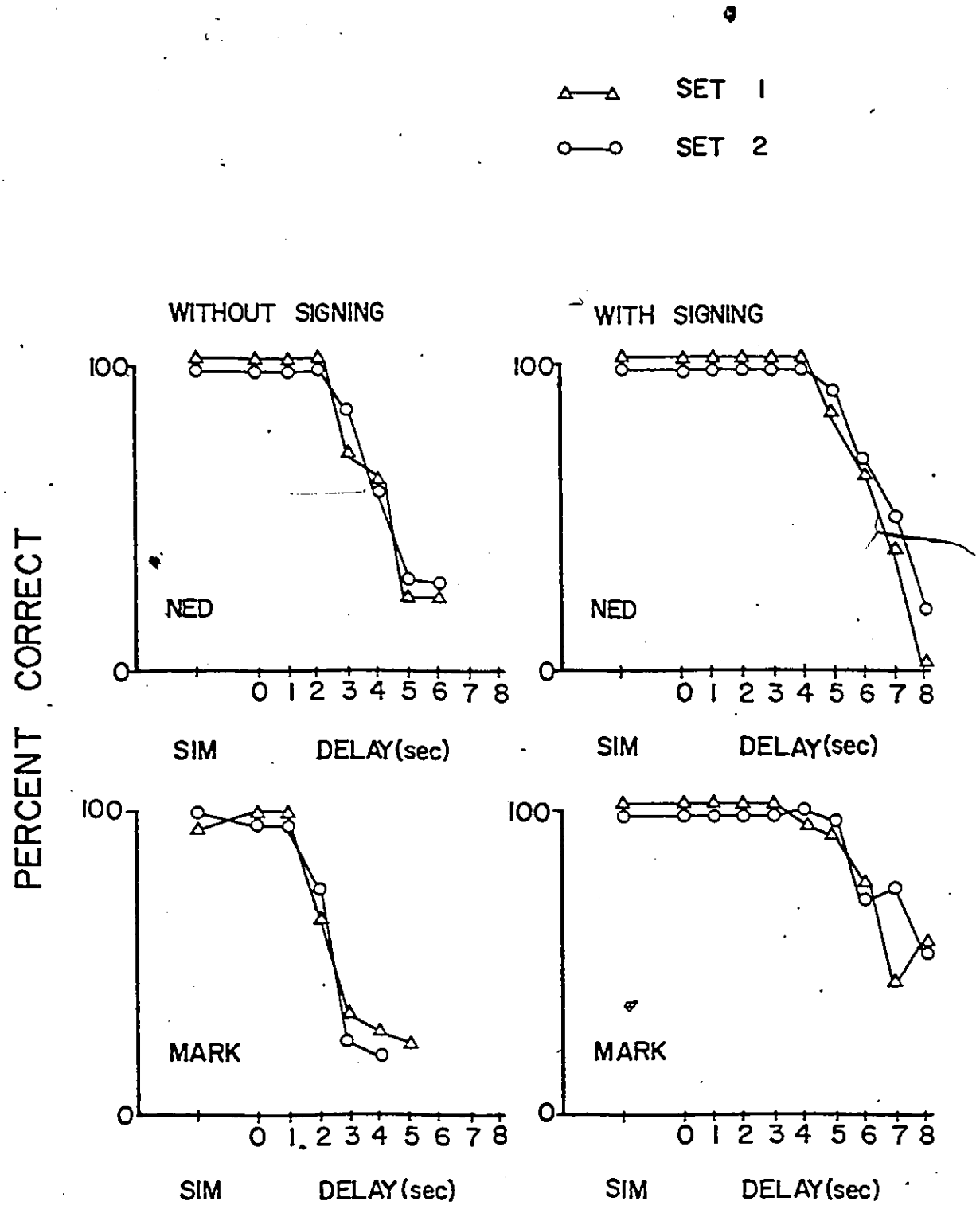
When the percentage of correct matches made during signed and unsigned trials between conditions (part 2 and part 1 of Experiment 2) were compared across different delay intervals, improvements were noted at each delay interval (see Figure 7). When Ned signed in response to an auditory sample, his selection of the appropriate choice stimulus did not approach chance level until a delay of eight seconds. Signing the sample stimulus also shifted the recall curve towards longer delay intervals for Mark. Even at eight seconds Mark continued to match correctly on over 50% of the trials. The points

Figure 6. Percentage of Correct Matches on Auditory-Picture D-M-T-S With and Without Signing for Part 2, Experiment 2.



Note. Trials are from the treatment sessions only. The stimulus set used appears above the bars. Terminal delay intervals for each child appear below the abscissa.

Figure 7. Percentage of Correct Matches on Auditory-Picture D-M-T-S Across Delay Intervals for Experiment 2.



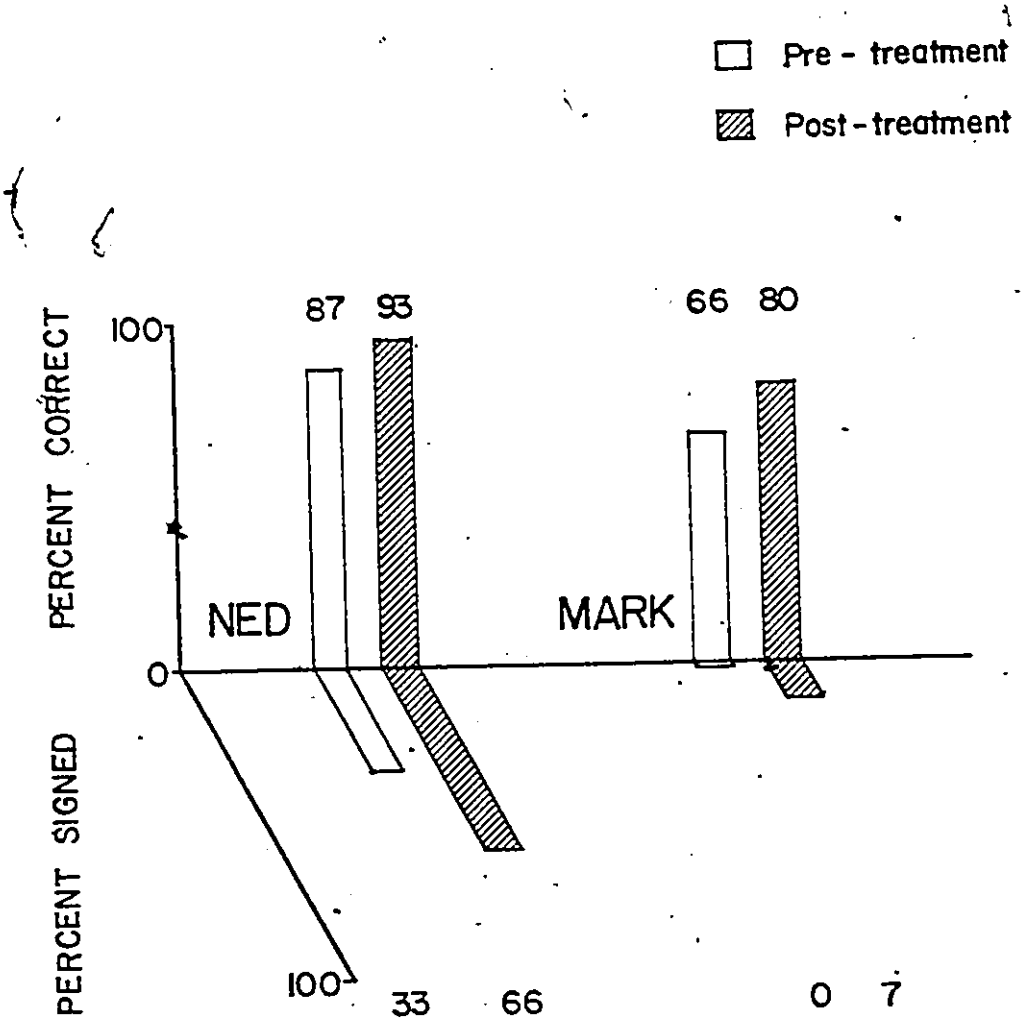
Note. Recall curves for without signing condition are based upon data from part 1, Experiment 2. Recall curves in the signing condition are based upon data from part 2 of Experiment 2. SIM= simultaneous.

on the graphs in Figure 7 represent a minimum of nine trials per stimulus set at each delay interval.

All the children who participated in the study were also receiving language training from their teachers, however, only Ned demonstrated speech. During the second part of Experiment 2 it was noted that occasionally Ned verbalized or responded in simultaneous communication (sign plus verbalization) when presented with an auditory sample stimulus. Ned's performance on the auditory-picture D-M-T-S tasks under different conditions are presented in Table 6. Note that the three strategies, saying the sample stimulus, signing the sample stimulus and saying and signing the sample stimulus were equally effective and all three strategies resulted in much better performance had no response been made. The percentages were based upon from nine to 22 trials.

Figure 8 presents the results of the generalization tests for Ned and Mark. The graph is to be interpreted in the same fashion as the graph presenting the generalization tests in Experiment 1. There was only a minimal improvement in matching accuracy on the post-test. For Ned, correct matching increased six percentage points and for Mark, the increase was 14 percentage points. Following treatment, Ned signed spontaneously

Figure 8. Percentage of Correct Matches and Spontaneously Signed Trials on Generalization Tests for Experiment 2.



Note. The exact pereentages are given above and below the appropriate bars. The sample stimuli were auditorally presented.

Table 6

Percentage of Correct Matches by Ned on Auditory-Picture D-M-T-S under Four Different Conditions

	Stimulus Set	
	1	2
Condition		
Verbal	92	78
Sign only	88	92
Sign + Verbal	79	86
No Response	21	33

Note. Trials are from part 2 of Experiment 2.

twice as often as compared to before treatment. Mark showed no significant increase in the number of spontaneously produced signs.

Delay intervals and standard deviations for the generalization tests are shown in Table 7. Once again, the delay intervals were longer than the delay intervals at which the children would be expected to perform above chance levels.

Table 7

Delay Intervals (Sec.) for the Generalization Tests in Experiment 2

	Ned		Mark	
	$\bar{x}$	σ	$\bar{x}$	σ
Pretest	9.4	2.2	10.8	5.1
Post-test	11.9	4.6	12.4	4.0

Discussion

Signing as a Mediator

The major intent of the two experiments reported in this study was to:

(a) Assess whether some verbal deficient children being trained in the use of sign language can be characterized as having a sign production deficiency.

(b) Assess whether sign language can function as an effective mediator for sign production deficient children in a D-M-T-S task.

The first purpose was supported by the results. Five cases of a sign production deficiency were observed in this study. Furthermore, the deficiency was observed when the stimulus was visually presented and when the stimulus was auditorally presented.

In part 1 of Experiment 1, Kim, Ned and Mark met all the conditions for a sign production deficiency for visually presented stimuli. All three children were able to correctly match pictures when the sample picture was present at the time the choice stimuli were presented yet unable to match the pictures when there was a relatively short delay between the removal of the sample picture and the presentation of the choice pictures. Furthermore,

these children were able to match the correct picture to the sign presented by the experimenter even under delay conditions and they were able to "name" all the pictures by signing.

The poor performance displayed by the three children does not appear to be a direct product of impulsive response styles since preventing the children from responding for an additional five seconds did not lead to more accurate matching responses. Although we cannot exclude the possibility that these children were not attending to the choice stimuli and "reflecting" upon them during the imposed five second delay interval a more likely explanation for their poor delayed picture matching performance is that they failed to utilize a potential mediation strategy (i.e., signing the sample stimulus) for which the children had all the required subskills.

When the sample stimulus was auditory, as in part 1 of Experiment 2, two children met all the conditions for a sign production deficiency. Ned and Mark were able to correctly match an auditory sample to the correct choice picture when the auditory sample was present at the time the choice stimuli were presented yet unable to perform this matching task when there was a relatively short delay between the termination of the auditory sample and the presentation of the choice pictures. Furthermore, both Ned and Mark were able to match the correct choice picture to the sign presented by the experimenter even under delay

conditions and they were able to respond to the auditory sample with the correct sign.

Once again, the poor performance in the auditory-picture D-M-T-S task can probably not be attributed to impulsive response styles as preventing Ned and Mark from responding for an additional five seconds failed to improve matching performance. Instead, Ned's and Mark's failure to utilize a potential mediation strategy (i.e., signing) for which they had the required subskills appeared to be responsible for their poor performance in the auditory-picture D-M-T-S task.

The results of the first parts of Experiment 1 and Experiment 2 clearly indicate the existence of a sign production deficiency in some children being trained in the use of sign language. For some children (e.g., Ned and Mark) a sign production deficiency was noted not only for visually presented stimuli but also for auditorally presented stimuli. These findings define an area which is problematic for children learning sign language and the findings also suggest a strategy for remediation. That is, there are children who perform poorly in memory tasks and the reason for their poor performance may be their failure to utilize existing skills (i.e., signing) that can potentially bridge the delay intervals involved. Whether or not signing can function in a facilitative

manner in delay tasks was the focus of the second purpose.

The results also supported the second purpose. Without exception, for each sign production deficiency demonstrated, an improved delayed matching performance resulted when the sample stimulus was signed by the subject.

When Kim, Ned and Mark were trained to sign in the presence of the sample picture (part 2 of Experiment 1) matching accuracy at the terminal delay interval improved from near chance levels (20%) to a minimum of 79% (Ned, Set N) and to a maximum of 100% accuracy (Kim, Set 4). This improved delayed picture matching performance as a result of signing the sample stimulus was observed as the children progressed from part 1 of Experiment 1 to part 2 of Experiment 1. In part 1 the children did not sign the sample picture in the D-M-T-S task and performance was near chance levels. In part 2 signing the sample picture was required and performance improved. In addition, the effectiveness of signing the sample picture upon delayed picture matching performance was observed within single sessions as in part 2 of Experiment 1. In the absence of the treatment (signing) matching accuracy was near chance levels (baseline condition). Introduction of the treatment consistently produced improved matching accuracy.

The effectiveness of signing as a mediator was also observed with an auditory sample stimulus. When Ned and

Mark were trained to sign in response to an auditory sample (part 2 of Experiment 2) matching accuracy improved from near chance levels (20%) to a minimum of 86% accuracy (Ned, Set 1) and to a maximum of 100% accuracy (Mark, Sets 1 and 2). In part 1 of Experiment 2 when signing was not required, matching accuracy in the auditory-picture D-M-T-S task was near chance levels. In part 2 matching accuracy improved as a result of signing the auditory sample. The treatment manipulation (i.e., signing the auditory sample) resulted in improved delayed matching performance even within the same session. In part 2 of Experiment 2 whenever the children failed to spontaneously sign in the presence of the auditory sample matching accuracy dropped to near chance levels from, as noted earlier, a minimum of 86% matching accuracy.

Thus, it appears reasonable to conclude that signing can function as an effective nonverbal mediator in a D-M-T-S task. Furthermore, the effectiveness of a sign mediation strategy extends not only to visually presented stimuli but also to auditorally presented stimuli.

Kendler and Kendler (1975) have argued that it is not necessary for a mediator to be verbal. Signing is of course nonverbal and thus, the present study along with Corsini et al (1968) and Ryan et al (1970) contribute to the growing empirical evidence supporting Kendler and

Kendler's (1975) position.

As noted in the introduction, Daehler et al (1969) did not find nonverbal mediators, more specifically, gestural mediators, to be effective. In their study, colored lights appeared in a random order on a display panel and the children were required to recall the locations where the lights appeared. The authors hypothesized that the older children would utilize gestural mediators (i.e., pointing) to facilitate recall of the locations where the colors appeared. They reasoned that gesturing, a nonverbal activity ocurring within space and over time, would be effective for "coding" spatial-temporal information (i.e., the locations of the lights). The results of their experiment failed to support the hypothesis.

Daehler et al's (1969) reported failure of gestures to function as nonverbal mediators may have resulted from the fact that gesturing is seldom used to facilitate recall and thus there is no reason to expect normal children to use gestures in a delay task. In the present study, children for whom gesturing (i.e., sign language) is the major means of communication, the results were quite different. For these children gesturing readily served as an effective nonverbal mediator.

Overall, the results of the two experiments indicate that signing can function as a nonverbal mediator in a

manner similar to that of verbal mediation. Instructions to utilize a verbal mediation strategy result in improved performance in delay tasks for individuals demonstrating verbal production deficiencies (Constantine & Sidman, 1975; Hagen & Kingsley, 1968; Hagen et al, 1968; Kellas et al, 1973). Likewise, instructions to utilize a sign mediation strategy result in improved performance in delay tasks for sign production deficient children.

Ned's performance in Experiment 2 (see Table 6) highlighted the functional similarity between sign mediation and verbal mediation. Ned performed equally well in the auditory-picture D-M-T-S task when he signed the sample stimulus and when he verbalized the sample stimulus.

Functional similarities between sign and speech, similar to that observed in Ned's case, have been observed by numerous investigators (Bellugi et al, 1975; Siple, Fischer, & Bellugi, 1977; Fulwiler & Fouts, 1976; Konstantareas, Oxman, & Webster, 1977). Such observations lend credence to the view that sign language is a language in its own right (Bellugi & Fischer, 1972; Stokoe, 1978). That is, the presence of speech is not a necessary and sufficient condition for defining language.

Viewing sign language as a language in its own right is problematic for theories that present language dysfunction as a critical feature of autism (Rutter & Bartak, 1971; Ricks & Wing, 1975). The use of speech by autistic

children has been advanced as an important prognostic indicator of future IQ levels for these children (DeMyer, Barton, DeMyer, Norton, Allen, & Steele, 1973; Rutter & Lockyer, 1967). The use of speech may be an insufficient prognostic indicator for some children who are trained in the use of sign language and thus, for these children, their use of sign language needs to be considered. For example, Salvin et al (1977) have shown increases in IQ to accompany increases is sign vocabulary. Since some nonverbal children can be taught sign language quite readily it appears that educators and clinicians may have within their grasp a valuable tool for changing the course of events for some of these children.

Both Experiment 1 and Experiment 2 demonstrated that a sign mediation strategy is responsive to training. This finding fails to support Luria's (1963) view that mediation is governed by biological processes and that mediation is not amenable to training. Numerous other investigators (Belmont & Butterfield, 1971; Brown, 1972; Butterfield et al, 1973; Kellas et al, 1973; Turnbull, 1974) have also failed to provide empirical support for Luria's (1963) position and instead the evidence emphasizes the importance of training verbal mediation strategies. This study extends the applicability of training verbal mediation strategies to the training of sign mediation strategies.

For some individuals (e.g., verbally deficient children) behaving under delay conditions may be especially problematic. These children not only lack the strategies which facilitate performance in delay tasks but they also lack the prerequisite language skills which provide the basis for many strategies. Consequently, the task for the educator is twofold. First, nonverbal children must be trained in an alternative language (e.g., sign language). Second, these children must then be trained to utilize existing sign language skills as a strategy which can facilitate performance under delay conditions.

With respect to the first task, training nonverbal children an alternative language, there is a growing consensus that sign language is a viable alternative to speech for some verbally deficient children. Sign language is not only widely used by the deaf (Reikehof, 1963) but it has also been taught with success to autistic (Bonvillan & Nelson, 1973; Salvin et al, 1977; Webster et al, 1973) and mentally retarded individuals (Kiernan, 1977; Topper, 1975).

The present study provides data regarding the second task, training sign proficient children to use sign language as a strategy which can facilitate performance under delay conditions. The results of this study

indicate that for some nonverbal children sign language can function as a mediator in a delayed matching task.

Generalization

The present study provides data relevant to three types of generalization. The first type is called maintenance of the trained response. In this study maintenance of the trained response would require that the children continue to use signing in the D-M-T-S task in the training environment without prompting from the experimenter. The second type of generalization is called generalization over time. Generalization over time would require that the children continue to sign in the D-M-T-S task without prompting from one day to another. The third type of generalization is called generalization across settings. Generalization across settings would require the children to sign in the D-M-T-S task without prompts in a situation different from the training situation.

In past investigations of verbal mediation most studies did not train the subjects to use verbal mediation strategies without continued prompts or in situations different from the training environment (Constantine & Sidman, 1975; Flavell, 1970). However, some investigators have demonstrated the generalization of verbal mediation

strategies over time (Butterfield et al, 1973; Kellas et al, 1973). In addition, many studies investigating the effects of training nonverbal children sign language have also failed to provide data regarding the three types of generalization noted (Bonvillan & Nelson, 1976; Miller & Miller, 1973).

The present study provided data regarding the three types of generalization noted. With respect to the first type of generalization, all the children trained to use sign as a mediator (part 2 of the two experiments) demonstrated the maintenance of signing behavior without the aid of prompts from the experimenter. Evidence for the maintenance of unprompted signing behavior in a delay task comes from two sources. First, there is the behavior that was observed in the training sessions (part 2 of both experiments). Each training session began with a number of trials in which signing in the presence of the sample stimulus was prompted and reinforced. Each training session ended with ten trials during which signing was neither prompted nor reinforced. After a number of these training sessions all the children reached a point where they continued to sign in the presence of the sample stimulus without prompts from the experimenter in a minimum of eight out of ten trials.

A second source of evidence for maintenance effects comes from a comparison of signing behavior in the

unprompted trials of the last training session with the signing behavior in the generalization test which followed one day later. In the generalization test the experimenter provided no prompts for signing yet the children continued to sign without the aid of prompts in the generalization test following training in a sign mediation strategy.

Generalization over time was also observed. All the children continued to use a sign mediation strategy 24 hours after training ended. On the last day of training the children signed, unprompted, in at least eight out of ten trials. Twenty-four hours later during the generalization post-test the children signed in the presence of the sample stimulus more frequently than in the pretest. Except for Mark who only signed in 7% of the post-test trials in Experiment 2, the minimum signing percentage in the generalization post-tests was 66% (Ned, Experiment 2).

The children also demonstrated the third type of generalization, generalization across settings. In the generalization post-tests of Experiments 1 and 2 there was an increase in the frequency of unprompted signing as compared to the generalization pretests (see Figures 4 and 8). That is, at the end of treatment the children also signed in response to new stimuli (both words and pictures) and they signed in a classroom setting different from the training environment.

For some children the increase in spontaneous signing in the generalization post-test was quite dramatic. For example, in Experiment 1 Ned signed in 20% of the pretest trials and he signed in 100% of the post-test trials. However, changes in the frequency of signing between the pre and post-tests were highly variable. Despite this variablity it should be noted that none of the children showed a decrease in signing behavior in the post-test as compared to the pretest.

The evidence indicates that training in the use of a sign mediation strategy did exert an effect that was not limited to the treatment sessions. The children that were trained in the use of a sign mediation strategy showed a maintenance of unprompted signing within a session and also over a time interval of one day. Furthermore, these children continued using a sign mediation strategy in the presence of novel stimuli and in a situation different from the training situation.

To increase signing behavior still more outside of the training environment a number of approaches are available (Stokes & Baer, 1977). From the nine approaches to increase generalization outlined by Stokes and Baer (1977) two appear readily adaptable to the present situation. The first approach that would in all likelihood lead to increased signing in novel situations would be

to impose a more stringent criteria for success in the training situation before testing in a novel situation. In this study the criteria in the training session for moving on to the generalization post-test was a minimum of eight unprompted signed trials out of ten trials. For some children this criteria was sufficient to produce signing behavior in a novel situation. Increasing the response requirements would in all likelihood lead to increased signing in a novel situation.

The second approach to increase signing behavior in situations outside of the training situation would be to train sign production deficient children to sign in the presence of a sample stimulus across a number of different situations simultaneously. For example, part of a session can be devoted to training on one set of stimuli in one situation and the remainder of the session can be completed in a different situation with a different set of stimuli. In this approach generalization across settings is directly trained via the manipulation of reinforcement contingencies.

Thus far, only the potentially more fruitful methods to increase generalization across settings were discussed. This type of generalization is often regarded as the most difficult to attain (cf. Lovaas et al, 1973) and therefore it has received the most attention. The maintenance of behavior and generalization over time

are, generally speaking, relatively easier to attain. Factors that have been identified as varying with these two types of generalization are number of reinforced trials (reinforcement density) and the schedule of reinforcement (Sidman, 1960).

Although an increase in spontaneous signing in the generalization post-tests was noted, an increase in matching accuracy did not necessarily follow (see Figures 4 and 8). That is, signing in the generalization post-tests failed to function as a mediator for it did not "influence the eventual course of behavior" (T. S. Kendler, 1963, p. 34). This may have been the result of a decreased reinforcement density or the result of longer delay intervals in the generalization tests (average delays ranged from 7.1 seconds to 12.4 seconds). Reinforcement density is a less likely explanation since signing behavior was observed to increase. It is more likely that matching accuracy in the generalization tests failed to improve with signing because the delays were longer than the delays in the treatment sessions (the children rarely performed successfully at delays beyond seven or eight seconds). A more appropriate test of the effectiveness of signing as a mediator in a novel situation would be to conduct the generalization test so that the delay intervals would be shorter (e.g. use a smaller classroom).

Since the longer delay intervals in the generalization post-tests appear most likely to have accounted for the failure of signing to function as an effective mediator, it appears that future research should focus upon developing

strategies to bridge these longer delays. Variations upon the basic sign mediation strategy, the effectiveness of which has been demonstrated in this study, appear likely to serve as a bridge for longer delays.

One variation may be to train sign proficient children to sign in the presence of the sample stimulus more than once. With speech proficient individuals repetition of verbal mediators (i.e., rehearsal) produces high performance levels at delays longer than had the verbal mediator been produced only once (Norman, 1969). Perhaps repeated signing in the presence of the sample stimulus can function in a similar manner for sign proficient children.

Another variation upon the basic sign mediation strategy that may be effective over longer delays would be to train sign proficient individuals to sign one or two seconds before their own terminal delay. Presumably the stimulus information would still be available for recall. Furthermore, signing at this point would serve to extend the period of time in which the stimulus could be recalled.

Butterfield et al (1973) in an experiment similar to the one just suggested found positive results. In addition to training mentally retarded individuals a verbal mediation strategy, they also trained the subjects

to pause after labelling visually presented letters and then repeat the letters a few seconds later. This strategy increased accuracy in recall beyond the simple labelling of letters without repetition.

Individual Differences

Only two of the children, Mark and Ned, displayed sign production deficiencies in both experiments. Kim displayed a sign production deficiency only in Experiment 1; Alice failed to display a sign production deficiency in either experiment.

These findings emphasize the highly situation specific behaviors displayed by children with severe behavioral dysfunctions. Kim and Alice, for example, displayed differential behavior as a function of the sensory modality of the sample stimulus. Such differential responsiveness to sensory stimuli has been noted previously among mentally retarded and autistic children (Lovaas et al, 1971; Wilhelm & Lovaas, 1976).

Not only were there variations in behavior as a function of the stimulus modality but there were also variations as a function of the testing situation and independent of the sensory modality. For example, in Experiment 2 Ned and Mark performed better in the generalization pretest than in the treatment phase of

the experiment where delay intervals were usually shorter.

Thus the results indicate that it is not a simple matter to make general statements about the effectiveness of a sign mediation strategy. Even for an individual we cannot make a statement unless we at least qualify it with reference to the sensory modality of the stimulus and the situation. A statement such as, autistic children perform poorly in memory tasks, is misleading. In this study Alice performed accurately over long delays when the stimulus was visually presented and Kim performed accurately when the stimulus was auditorally presented.

Since the presence of a sign production deficiency and the effectiveness of a sign mediation strategy appears to vary from individual to individual, future investigators must bear in mind this highly individual quality. Thus, investigators may wish to employ a small N or single subject research design to highlight any individual variation. This research design focuses upon the behavior of an individual and allows for a more accurate assessment of the conditions under which a sign production deficiency ocurrs and the conditions under which the deficiency can be eliminated by training in a sign mediation strategy.

Summary and Conclusions

Two major findings were noted in the present study. First, some children trained in the use of sign language can be characterized as sign production deficient. That is, these children perform poorly in a D-M-T-S task eventhough they have the basic skills that can potentially function to improve performance in the D-M-T-S task. Second, given a sign production deficiency, training in a sign mediation strategy effectively overcomes the deficiency. That is, signing the sample stimulus allowed sign production deficient children to perform more accurately at delays which previously produced poor performance.

The presence of a sign production deficiency and its amelioration by using a sign mediation strategy was observed for both visually and auditorally presented stimuli. Although the presence of a sign production deficiency may vary as a function of the sensory modality of the stimulus, once given, the effectiveness of a sign mediation strategy across the visual and auditory modalities remains constant.

Not only can sign production deficient children be trained to use an effective sign mediation strategy but training in the use of this mediation strategy also

resulted in some maintenance effects and generalization over time. The children were able to use the strategy without constant prompting from the experimenter up to 24 hours after the end of training in the strategy. Furthermore, they continued to sign in situations different from the training situation and in response to novel picture and auditory stimuli.

A great deal of evidence has now accumalated indicating that sign language may be an alternative to speech for communicating with some nonverbal individuals. Although continued research is needed to arrive at the most effective method for training sign language to these children, it is time to assess the role of sign language in other areas of behavior. Studies investigating the role of sign language in memory tasks with intellectually normal adults (Bellugi et al, 1975; Furth, 1966) opened the door to a new area of investigation and the results of the present study encourage further research in this direction.

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