A Nonvocal Method for Teaching Reading and Spelling to the Deaf

Amy A. Barmeier
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A NONVOCAL METHOD FOR TEACHING READING AND SPELLING TO THE DEAF

Amy Astri Barmeier, Ph.D.
Western Michigan University, 1981

Teaching reading and spelling to the deaf requires materials and methods which compensate for the two problems of the deaf child. The first is that the deaf typically have a small verbal history in either the sign language or lipreading modes. The second is that the deaf cannot identify unknown written words by phonetically sounding them out. In comparison, the hearing child has sophisticated sounding out skills and an extensive auditory-vocal history.

The seven experiments in this research investigated a method for teaching vocabulary comprehension and spelling to the deaf which assumed neither a verbal history with respect to the words, nor sounding out skills. A sign language mediated transfer paradigm provided the framework for the investigation. This paradigm consisted of eight matching-to-sample tasks involving printed words, pictures, sign language words, and fingerspelled words.

In each experiment, the first procedural step was to pretest the deaf subject's knowledge of a group of words. Each of the eight tasks in the sign language mediated transfer paradigm was administered in the pretest. Specifically, the subject was required to (a) match printed words to their pictures, (b) match pictures to printed words, (c) sign when shown a picture, (d) fingerspell when shown a picture, (e) sign when shown a printed word, (f) choose the
picture when a word was fingerspelled to him, (g) choose the picture when a word was signed to him, and (h) choose the printed word when a word was signed to him.

Following the pretest, the subject was taught two of the tasks. He first learned to match pictures to signed stimuli. He was then taught to match printed words to signed stimuli. This second task included a spelling drill after each correct printed word choice. Two spelling drills (zero delay, simultaneous) and two spelling modes (fingerspelling, writing) were investigated during this procedural phase.

After the subject had learned these two tasks, all of the eight tasks were administered as a posttest. The purpose of the posttest was to assess transfer, this being defined as a spontaneous improvement in the subject's posttest scores for the six tasks that were not taught.

The seven experiments in this research investigated three experimental questions. These were (a) transfer, (b) a comparison of spelling drills, and (c) a comparison of spelling modes and an assessment of spelling generalization.

With respect to the first, transfer did occur in all seven experiments. In general, the subjects performed poorly on all pretest tasks. They were then taught two of the tasks and a spelling drill. After learning these, they responded correctly on the six untrained tasks during the posttest.

With respect to the second experimental question, the zero delay
and simultaneous spelling drills were compared. In the zero delay drill, the subject had to recall the spelling of the word. In the simultaneous drill, he looked at the printed word and copied its spelling. The zero delay drill proved superior.

The third experimental question involved a comparison of writing and fingerspelling in the zero delay drill, and an assessment of spelling generalization from one mode to the other. The results indicate that either mode may be used, and that generalization readily occurs. The subjects preferred writing to fingerspelling.

The paradigm and procedures used throughout this research are well suited to the needs of the deaf for several reasons. The first is that teaching the deaf student to match pictures and printed words to signed stimuli provides him with, respectively, a verbal history and an alternative to sounding out skills. Second, the procedural steps of (a) pretest, (b) teach two tasks and a spelling drill, and (c) posttest are self-paced and individualized. Third, the procedure is simple enough to be administered by a teacher's aide, parent, or older student. Finally, the eight tasks in the paradigm are comprehensive and include all of the behavioral skills involved in reading.
ACKNOWLEDGEMENTS

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Amy A. Barmeier
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CHAPTER I

INTRODUCTION

Past Research on the Reading Achievement of the Deaf

Research conducted throughout the last 64 years has shown that deaf children, deaf adolescents, deaf college students, and deaf adults are significantly poorer readers than their hearing peers. One consistent finding is that the average deaf adult has the reading ability of, at best, a fourth to sixth grade hearing student. Another is that deaf students progress much slower in reading than the hearing and may gain as little as one grade level in achievement during a span of 5 to 7 school years (Annual Survey of Hearing Impaired Children and Youth, 1971; Babbidge, 1965; Balow, Fulton, & Peploe, 1971; Chasen & Zuckerman, 1976; Furth, 1966; Goetzinger & Rousey, 1959; Hall, 1929; Hammermeister, 1971; Johnson, 1948; Klopping, 1972; Lane & Baker, 1974; Magner, 1964; McLaughlin & Andrews, 1975; Meadow, 1968; Montgomery, 1966; Pintner & Patterson, 1917; Pugh, 1946; Quigley, 1967; Stevenson, 1964; Stuckless & Birch, 1966; Trybus & Karchmer, 1977; Vernon & Koh, 1970, 1971; White & Stevenson, 1975; Wrightstone, Aranow, & Moskowitz, 1963).

In general, these comparisons of the deaf and hearing are made by (a) determining the average age of a deaf sample, (b) determining the average reading level of the deaf sample, and (c) comparing the age and reading level of the deaf sample with the norms already established for hearing children.
Wrightstone, Aranow, and Moskowitz (1963) conducted one of the most comprehensive, well designed, and widely quoted studies in this line of research. They administered the reading series of the Metropolitan Achievement Test (MAT) to 5,307 deaf students between the ages of 11 and 16. Their sample was geographically well distributed, and represented 54% of the target population of all deaf students between the ages of 11 and 16 who have an IQ of at least 75. The purpose of the study was to establish normative data on the reading achievement levels of normal deaf students at each of these ages.

Furth (1966) compared the Wrightstone et al. (1963) data with the, at that time, recently established MAT norms for hearing children. Furth's calculations demonstrated that, between the ages of 11 and 16, deaf children improve in reading from an average grade level of 2.7 to 3.5. In other words, the average deaf 16 year old reads as well as a hearing child in the third grade, and deaf students gain less than one grade level in reading achievement during a 6 year educational period.

This poor reading achievement cannot be blamed on a general lack of intelligence because it has been shown that the deaf equal their hearing peers on nonverbal intelligence tests (Furth, 1961; Hiskey, 1956; Young & McConnell, 1957). Moreover, it is also inaccurate to hypothesize that the deaf cannot perceive written words. Research has shown that they equal the hearing on word perception tasks, and equal or exceed the hearing on tests of spelling ability (Gates & Chase, 1926; Hoemann, Andrews, Florian, Hoemann, & Jensema, 1976;
Why the Deaf Cannot Read

The average deaf adult may read at the fifth or sixth grade level because he only has the vocabulary of a fifth or sixth grader. Research has shown that deaf students score significantly lower than their hearing peers on vocabulary comprehension tests (Balow, Fulton, & Peploe, 1971; Conley, 1976; Doehring & Rosenstein, 1960; Pugh, 1946; Van Uden, 1971; Young & McConnell, 1957). The implication is that without an adequate vocabulary, the deaf cannot learn the more complex aspects of English such as syntax, grammar, idioms, and figurative expressions.

With respect to both low reading achievement and vocabulary comprehension, deaf educators are beginning to admit that the inadequacy is not in the deaf child, but rather in the materials and methods used to teach reading to the deaf (Conley, 1976; Hargis, 1970; LaSasso, 1978; McCarr, 1973; Newby, 1974).

LaSasso (1978) recently surveyed 960 deaf education programs to determine what materials and methods were being used with the deaf, and whether the teachers of the deaf regarded the materials and methods as adequate. Responses were received from 507 programs, a return rate of 52%.

At the time of the survey, 73% of the programs reported using a basal reading series in their reading curricula. Almost half of these programs, however, reported problems with the basal readers.
They stated that (a) the vocabulary was too difficult and not repeated enough, (b) the idioms, syntax, and figurative expressions were too complicated, (c) there was too much emphasis on phonics, and (d) the basal series were, in general, designed for a linguistically competent hearing student.

Of the 507 respondents in LaSasso's survey, 41.7% were using an individualized approach to reading instruction in which students read library books, trade books, and newspapers. Most of these programs were using the individualized approach because they were unable to find a suitable basal reading series. Thirty-six percent of the 507 programs were using some type of programmed materials, the most popular being Project LIFE. Project LIFE is a programmed series designed for the deaf (Pfau, 1974).

LaSasso's survey also indicated that the teachers of the deaf are dissatisfied with the available reading materials. Of the 507 respondents, 75% stated that the top research priority should be to develop either materials or instructional strategies which have been specifically designed for, and proven successful with the deaf. Most teachers of the deaf are currently using a basal reading series designed for the hearing, despite the fact that the deaf students do not understand the linguistic structures and syntax in the basal readers (Quigley, Power, & Steinkamp, 1977).

A Behavioral Analysis of Deaf Reading Instruction

Designing reading materials to meet the needs and problems of the deaf requires an analysis of the verbal differences between deaf
and hearing persons. The first difference concerns the size and mode of their verbal histories. Hearing children typically have an extensive auditory-vocal history when reading instruction begins. The environment provides the hearing child with clear auditory stimuli on an almost constant basis from birth onward. They learn vocal English through the processes of imitation and generalization, and typically show effective grammatical and syntactical verbal behavior by the time they are 3.5 to 4 years old (McNeil, 1966). When formal reading instruction begins, the hearing child is learning only to identify the written version of a language he already knows in the auditory-vocal sense.

The deaf child, on the other hand, has no such auditory-vocal history. He may have a verbal history in either sign language or lipreading, but neither of these can be as extensive as the auditory-vocal history of the hearing child. The problem with lipreading is that the verbal information is highly ambiguous, with only half of the spoken phonemes visible on the lips (Erber, 1974; Fusfeld, 1958; Lewis, 1972; Pauls, 1970). Sign language provides clear verbal information, but is not used by most hearing people, television, radio, or the movies. Thus, when the deaf child learns to read, he must not only learn to identify written English, but also learn the rules of syntax, grammar, idioms, and figurative language (Conley, 1976; Hargis, 1970; Quigley, Power, & Steinkamp, 1977).

The second difference between deaf and hearing children is the extent to which they have a set of skills for sounding out and blending the letters of unfamiliar words. The hearing child is again at
an advantage. Assuming that he can vocalize the phonemes, the hearing child can attack and comprehend written words by (a) phonetically sounding out the letters of the word, (b) saying the word aloud, (c) reacting to his own vocalization as a listener, (d) modifying his vocalization until it sounds right, and then (e) drawing on his extensive auditory-vocal history for the referent of the word (Skinner, 1957). The hearing child, therefore, has a set of sounding out skills which enable him to identify unknown written words.

Deaf children cannot use these sounding out skills as a means of identifying and comprehending an unknown written word. They cannot hear, and therefore cannot vocally sound out a word or rely on an extensive auditory-vocal history for the meaning of the word. Because written words do not stand in point-to-point correspondence with manual signs, there is no sign language analog to the hearing child's sounding out skills.

Fingerspelling does stand in point-to-point correspondence with written words. Given that a deaf child could fingerspell and read fingerspelling as well as the hearing child speaks and understands speech, attacking unknown written words by fingerspelling them would be a reasonable analog to sounding out skills. However, fingerspelling is neither popular with the deaf as a means of communication, nor is it used by the hearing community.

To summarize this analysis, a hearing child can rely on an auditory-vocal history and sounding out skills when learning to read. In contrast, the deaf child has a smaller verbal history, and cannot identify unknown written words by sounding them out.
This analysis has three implications for the materials and methods used to teach reading to the deaf. First, they should teach a verbal history in either the sign language or lipreading mode. Second, they should either eliminate the need for sounding out skills, or provide the deaf child with a reasonable alternative. Finally, they should not assume a repertoire of vocabulary, idioms, figurative expressions, syntax, or grammar; deaf students require a controlled introduction to all of these aspects of the English language.

Scope of the Present Research

The present research was undertaken to design and experimentally evaluate a method and materials for teaching vocabulary and spelling to the deaf. The method investigated was derived from Sidman's (1971, 1973, 1974, 1977) research on reading instruction in which he used an auditory-vocal mediated transfer paradigm. Sidman's paradigm was chosen as the basis for this research on deaf reading instruction because neither a verbal history nor sounding out skills are required.
CHAPTER II

EXPERIMENTAL RATIONALE

Sidman's Mediated Transfer Paradigm and Research

Sidman (1971, 1973) designed and investigated a method of teaching reading to profound retardates who had normal hearing. His subjects had had no prior academic training or reading instruction. The teaching procedure was based on an auditory-vocal mediated transfer paradigm. As shown in Figure 1, this paradigm consisted of six matching tasks involving spoken words, pictures, and printed words. The paradigm behaviorally defines the skills involved in effective reading, and provides a framework from which to investigate reading instruction (Sidman, 1977; Wulz & Hollis, 1979c).

Each task in the paradigm has a distinct stimulus/response combination. In the auditory comprehension task, the stimulus was a spoken word and the subject responded by choosing the corresponding picture. In picture naming, the teacher presented a picture and the subject vocally named it. In the two reading comprehension tasks, the subject matched printed words to pictures, and pictures to printed words. In auditory receptive reading, the stimulus was a spoken word and the subject chose the corresponding printed word. In oral reading, the subject read printed words out loud.

Two of the tasks in Sidman's paradigm provide an operational definition of reading comprehension, that being the ability to match printed words and pictures. The other four tasks in the paradigm
Figure 1. Sidman's auditory-vocal mediated transfer paradigm.
provide operational definitions of terms used in the preceding behavioral analysis of deaf reading instruction, these being sounding out skills and a verbal history. The auditory-vocal verbal history is represented in Sidman's paradigm by the auditory comprehension and picture naming tasks. Sounding out skills are represented in Sidman's paradigm by the auditory receptive reading and oral reading tasks.

The first step in Sidman's (1971, 1973) procedure was to pretest the subject's knowledge of the words. He did this by administering each of the six tasks in the mediated transfer paradigm. In general, the subjects performed at or below the chance level of accuracy on this pretest of the six tasks. They were not able to match the pictures and printed words (reading comprehension 1 and 2), sound out the printed words (oral reading, auditory receptive reading), or match spoken words and pictures (auditory comprehension, picture naming).

Following the pretest, Sidman taught the subjects to do the auditory comprehension and auditory receptive reading tasks. That is, they were first taught to match pictures to spoken words (auditory comprehension). They were then taught to match printed words to spoken words (auditory receptive reading). After the subject had learned these two tasks, all six tasks in the paradigm were administered as a posttest.

The significant finding was that the subjects were 80% to 100% correct on all six posttest tasks. This spontaneous improvement in the four posttest tasks that were not taught is called "transfer".

The four untrained tasks are reading comprehension 1, reading
comprehension 2, picture naming, and oral reading. Reading comprehension 1 and 2 are receptive tasks; picture naming and oral reading are expressive tasks. In general, the development of the two expressive types of behavior assumes more than the development of the two receptive behaviors. In the two receptive untrained tasks, the only prerequisite skill is the ability to point to a picture or printed word. In the two expressive tasks, the subject develops new vocal behavior, with the necessary prerequisite skills being an echoic repertoire and a tendency to engage in echoic behavior during the experiment.

Sidman's procedure and results have been systematically replicated by independent investigators, all of whom used retardates as subjects (Gast, Van Biervliet, & Spradlin, 1979; Wulz & Hollis, 1979a, 1979b). In all of these replications, teaching two tasks (auditory comprehension, auditory receptive reading) produced transfer to the four untrained tasks.

Other research on Sidman's paradigm has shown that teaching auditory comprehension and auditory receptive reading is not the only way to produce transfer to four untrained tasks. Teaching auditory comprehension and one of the reading comprehension tasks produces transfer (Sidman, 1974), as does teaching auditory receptive reading and one of the reading comprehension tasks (Wulz & Hollis, 1979a, 1979b).

Teaching only one task, however, does not produce transfer (Wulz & Hollis, 1979a, 1979b). When retarded subjects were taught only one reading comprehension task, transfer occurred only to the other
reading comprehension task. In another experiment, subjects were taught only auditory receptive reading. After learning this, they were able to read printed words out loud (oral reading), but could not do the other four tasks.

Using retarded subjects who could hear, Van Biervliet (1977) conducted Sidman's (1971, 1973) procedure in sign language. Signs were substituted for the auditory stimuli, and the subjects signed their responses rather than vocalizing. In contrast with previous research, Van Biervliet used nonsense signs, words, and pictures rather than English vocabulary words. His subjects showed transfer to the four untrained tasks after being taught to match pictures to signed stimuli (auditory comprehension), and to match printed words to signed stimuli (auditory receptive reading). As with the development of new vocal behavior, transfer to the two expressive signing tasks requires that the subject already have the ability to imitate another person's signing, and have some tendency to do so during the experiment.

From the research conducted, it appears that teaching two tasks is the critical variable in producing transfer. Although all possible combinations have not yet been experimentally investigated, transfer occurs when the two tasks involve the picture, the printed word, and the auditory word.

Sidman (1977) explains transfer in terms of the development of stimulus classes. He contends that learning auditory comprehension and auditory receptive reading results in the picture, printed word, and spoken word becoming equivalent stimuli. This enables the
retarded subjects to match pictures and printed words, read printed words out loud, and vocally name pictures, despite the fact that these skills were not directly taught.

Although the transfer procedure has been successful in teaching the profoundly retarded to read, using it to teach normal hearing children would probably be a redundant process. Before learning to read, the normal hearing child already knows the auditory comprehension and picture naming tasks for thousands of words. His verbal repertoire already contains relationships between the words that he hears and the objects or events related to these words. Moreover, sounding out skills enable the normal hearing child to spontaneously do the auditory receptive reading and oral reading tasks for unfamiliar printed words. He can determine the written equivalent of a spoken word and also vocalize unknown written words by using his sounding out and blending skills. Thus, transfer is an automatic process for the hearing; they can use their auditory-vocal verbal histories and sounding out skills to spontaneously create a stimulus class consisting of the picture, printed word, and spoken word.

**Purpose of the Present Research**

The purpose of the present research was to determine if transfer occurs when Sidman's (1971, 1973) procedure is conducted in sign language with profoundly deaf students of near normal intelligence. With respect to reading instruction, this procedure is well suited to the needs of the deaf for several reasons. First, unlike hearing students who have extensive verbal histories, the deaf student may
not already know the auditory comprehension and picture naming tasks for the words he is learning to read. Second, because deaf students do not have vocal sounding out skills, they cannot spontaneously figure out the auditory receptive reading and oral reading tasks for unknown printed words. Therefore, when an unknown printed word is encountered, the deaf student cannot create a stimulus class consisting of the picture, printed word, and spoken word. Transfer cannot be assumed with the deaf, but rather must be specifically engineered.

The sign language mediated transfer paradigm used in each of the 7 experiments in this research is diagrammed in Figure 2. The sign language paradigm consists of eight tasks, six of which parallel Sidman's, the only difference being the use of sign language rather than vocal English. The sign language paradigm differs from Sidman's auditory-vocal paradigm by including expressive and receptive fingerspelling. In the expressive fingerspelling task, the subject is shown each picture and required to fingerspell its name. In the receptive fingerspelling task, a word is fingerspelled to the subject and he is required to choose the corresponding picture.

The present experiments replicate Sidman's (1971, 1973) procedure; two tasks were taught to the deaf subjects and transfer was measured by the posttest scores on the six untrained tasks. Whereas Sidman's paradigm assessed transfer to four untrained tasks, the present experiments assess transfer to six untrained tasks. Sign comprehension and signed receptive reading were the two tasks taught because they, respectively, teach a verbal history and provide an
Figure 2. The sign language mediated transfer paradigm.

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alternative to sounding out skills.

A second purpose of this research was to investigate two different spelling drills during the teaching of signed receptive reading. In Sidman's (1971, 1973) procedure for teaching auditory receptive reading, the retarded subjects repeatedly matched printed words to spoken stimuli until they no longer made errors. In the signed receptive reading procedure used in this research, the deaf subjects not only matched printed words to signed stimuli, but also practiced spelling the word after each correct matching response. Two different spelling drills were compared.

A final purpose of this research was to compare two different spelling modes. Writing and fingerspelling were the two modes investigated; spelling generalization from one mode to the other was assessed.
CHAPTER III

GENERAL METHOD

Subjects

A 21 year old profoundly deaf male (L.V.) served as the subject in Experiments 1 through 5. L.V. was mildly retarded and enrolled in a special education program for emotionally impaired teenagers. The program included (a) instruction in academic skills such as reading, cooking, banking, math, and first aid, and (b) 20 hours per week of paid work in a sheltered workshop. Prior to this placement, L.V. had failed in the deaf classroom of the local public high school. He had a sign language vocabulary of approximately 500 words, and could recognize and produce the 26 characters in both the orthographic and fingerspelling alphabets. According to standardized achievement tests, he read at the second grade level. To communicate with others, L.V. combined single signs with skilled pantomime. His vocal speech was unintelligible, yet effectively conveyed emotions such as excitement, sadness, and irritation. Aside from his deafness, L.V. had no physical handicaps. Socially, he was gregarious with his peers and teachers.

A profoundly deaf 23 year old male (H.O.) served as the subject in Experiments 6 and 7. H.O. was enrolled in a special education program for multiply handicapped teenagers. He had previously attended, and become a behavior problem in the deaf classroom in the local public high school. H.O. had scored in the low-normal range on in-
telligence tests. He could recognize and produce the 26 characters in the orthographic and fingerspelling alphabets. His sign language vocabulary was approximately 750 words. H.O. had no physical handicaps aside from his deafness. His teachers reported him as being bored, unmotivated, and a loner. H.O. rarely initiated signed verbal interactions, and never vocalized.

**Apparatus**

All experiments were conducted at a table in a school classroom. The subject and experimenter sat across from each other, with the former facing a blank wall.

No mechanical apparatus was used. The four types of sample stimuli were presented by the experimenter. These included (a) a signed word, (b) a fingerspelled word, (c) a printed word, and (d) a picture. The signs were executed twice by the experimenter. Fingerspelled stimuli were executed approximately 50 cm from the subject's eyes, at the rate of 1.5 sec per character. The printed words were 1.5 cm high and centered on individual white index cards. The picture stimuli varied, and are described separately for each experiment.

Throughout each experiment, the subject made five different types of responses. These included (a) signing, (b) fingerspelling, (c) writing or printing, (d) pointing to a picture, and (e) pointing to a printed word. The first two responses required no materials. For each written response, the subject used a small piece of paper. For each of the two pointing responses, the experimenter shuffled and placed the choice stimuli on the table. All of the printed words or
pictures in each particular experiment were presented as choices for each pointing response.

**Procedure**

Table 1 presents the word sets used in each of the 7 experiments. Each experiment had the following four phases: (a) pretest, (b) teach sign comprehension, (c) teach signed receptive reading, and (d) posttest. Sessions were held each school day for 30 minutes. The pretest and posttest each required one session. Teaching sign comprehension and signed receptive reading required several sessions.

The procedures used to pretest, teach sign comprehension, and posttest were identical in all experiments. The procedure used to teach signed receptive reading varied across and within experiments.

**Pretest**

Each of the eight tasks in the sign language mediated transfer paradigm was administered to pretest the subject's knowledge of the words. The stimulus, response, and signed instruction given for each task are shown in Table 2. The expressive and receptive fingerspelling tasks were administered first and second, respectively, to prevent the subject from seeing the printed words prior to the assessment of these baseline skills. The order of the remaining six pretest tasks, and the order of the words within each task, were randomly determined. For each task, the experimenter arranged the necessary stimulus and response materials, and then signed the instructions to the subject.
<table>
<thead>
<tr>
<th>Experiment</th>
<th>Number of Words</th>
<th>Word Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>cake, butter, peach, bread, carrot, cheese, apple, orange, banana</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>tomato, cookie, onion, grapes, cracker, potato, bacon, coffee, chicken</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>turkey, horse, turtle, rabbit, pencil, doctor, window, flower, monkey</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>Georgia, Vermont, Montana, Alabama, New York, Arizona, Wyoming, Indiana</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>New Mexico, Minnesota, Wisconsin, Louisiana, Tennessee, New Jersey</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>Georgia, Vermont, Montana, Alabama, New York, Arizona, Wyoming, Indiana</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>Colorado, Oklahoma, Nebraska, Delaware, Missouri, Kentucky, Illinois, Virginia</td>
</tr>
</tbody>
</table>
Table 2
The Stimulus, Response, and Instruction Given in Each
of the Eight Pretest Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Stimulus Presented</th>
<th>Subject's Response</th>
<th>Instruction Givena</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign Comprehension</td>
<td>sign</td>
<td>point to picture</td>
<td>&quot;I sign, you choose picture&quot;</td>
</tr>
<tr>
<td>Signed Receptive Reading</td>
<td>sign</td>
<td>point to word</td>
<td>&quot;I sign, you choose word&quot;</td>
</tr>
<tr>
<td>Receptive Fingerspell</td>
<td>fingerspelled word</td>
<td>point to picture</td>
<td>&quot;I fingerspell, you choose picture&quot;</td>
</tr>
<tr>
<td>Expressive Fingerspell</td>
<td>picture</td>
<td>fingerspell</td>
<td>&quot;I show picture, you fingerspell name&quot;</td>
</tr>
<tr>
<td>Reading Comprehension 1</td>
<td>picture</td>
<td>point to word</td>
<td>&quot;I show picture, you choose word&quot;</td>
</tr>
<tr>
<td>Reading Comprehension 2</td>
<td>printed word</td>
<td>point to picture</td>
<td>&quot;I show word, you choose picture&quot;</td>
</tr>
<tr>
<td>Manual Naming</td>
<td>picture</td>
<td>sign</td>
<td>&quot;I show picture, you sign name&quot;</td>
</tr>
<tr>
<td>Manual Reading</td>
<td>printed word</td>
<td>sign</td>
<td>&quot;I show word, you sign name&quot;</td>
</tr>
</tbody>
</table>

aThe instructions were presented in sign language by the experimenter.
The subject's pretest responses were scored as correct or incorrect. In expressive fingerspelling, the actual letters fingerspelled by the subject were recorded. The reliability of these observations was assessed by an independent observer who was skilled in sign language and fingerspelling. There was no reinforcement, punishment, or correction for any of the subject's pretest responses.

**Teach sign comprehension**

Sign comprehension was the first of two tasks taught to the subject. As diagrammed in Figure 3, this procedure began with a signed stimulus. If the subject pointed to the correct picture, the experimenter smiled and signed "correct". If the subject's response was incorrect, the experimenter frowned, signed "wrong", presented the same signed stimulus again, and instructed the subject to make another choice. The experimenter recorded whether the subject's initial picture choice was correct or incorrect.

After each correct response, the experimenter presented the next signed stimulus. The order of these stimuli was random, with the stipulation that no word be repeated until each had been presented once. A word set trial was completed when each word in the set had served as the signed stimulus once. Sign comprehension was taught in this manner until the subject's initial responses were correct on four consecutive word set trials.
Figure 3. The sign comprehension teaching procedure.
Teach signed receptive reading

Signed receptive reading was the second task taught to the subject, and involved matching printed words to signed stimuli and then a fingerspelling drill. The spelling drill and spelling mode used during this procedural phase varied across experiments. The two spelling drills investigated were a zero delay drill and a simultaneous drill. The two spelling modes were writing and fingerspelling.

The zero delay and simultaneous spelling drills are diagrammed in Figure 4. The first two steps in both drills were identical: the subject chose the printed word corresponding to a signed stimulus. If he chose the correct printed word, the experimenter smiled, signed "correct", and started the spelling drill being used in the experiment.

In the zero delay drill, the experimenter removed the printed word from view and the subject fingerspelled it. If the subject made a fingerspelling error, the experimenter frowned, signed "wrong", presented the word for another 4 sec, and then told the subject to fingerspell the word again. When the subject spelled the word correctly, the experimenter smiled, signed "correct", and presented the signed stimulus for the next word.

During the zero delay drill, the signed stimuli were presented in a random order such that all words were presented once before any were repeated. One stimulus presentation of each word in the set comprised a word set trial. The experimenter recorded whether the subject's initial printed word choice and his initial spelling response were correct or incorrect. The zero delay drill was run.
Figure 4. The zero delay and simultaneous spelling drills.
until both of the subject's responses to each signed stimulus were
correct for four consecutive word set trials.

As diagrammed in Figure 4, the simultaneous drill was a more
simple procedure than the zero delay drill. In the simultaneous
drill, the subject looked at the printed word while fingerspelling
it. If he made a spelling mistake, the experimenter frowned, signed
"wrong", and told the subject to start over. The data collected dur­
ing the simultaneous drill were identical to those described for the
zero delay drill.

The difference between the zero delay and simultaneous drills
was whether the subject had to, respectively, recall or copy the
spelling of the word. In the former, the subject was not permitted
to look at the printed word while spelling it; he had to recall its
spelling. In the latter, he looked at the printed word and copied
its letters while spelling.

Both of these drill procedures have the same prerequisite skills:
the subject must be able to identify and produce the 26 characters
in the fingerspelling or orthographic alphabets.

Spelling probe tests

The expressive fingerspelling task was administered as a probe
during the spelling drill procedure in Experiments 2, 3, and 4. The
purpose of this probe test was to compare the relative effectiveness
of the zero delay and simultaneous drills. The probe test procedure
was identical to the expressive fingerspelling pretest. That is,
each picture was presented and the subject fingerspelled its name.
There was no reinforcement, punishment, or correction for any spelling responses during the probe tests.

Posttest

The posttest was administered the day after the subject had learned the spelling drill used in each experiment. The posttest procedure was identical to the pretest.

Experimental Design

This research consists of 7 experiments, each of which has the following four phases: (a) pretest, (b) teach sign comprehension, (c) teach signed receptive reading, and (d) posttest. The pretest, posttest, and sign comprehension teaching procedure were identical in all 7 experiments. The signed receptive reading procedure, however, varied across experiments in terms of spelling drill (zero delay, simultaneous) and spelling mode (writing, fingerspelling).

Table 3 presents the spelling drill, spelling mode, and experimental questions of each of the 7 experiments. With respect to the experimental questions, all experiments investigated transfer. The subjects' pretest and posttest scores were compared, and transfer defined as an improvement in the posttest scores of the six untrained tasks.

The zero delay and simultaneous spelling drills were compared in Experiments 3 and 4. The relevant data were how fast the subject learned each drill, and how well he performed on expressive fingerspelling probe tests while learning each drill.
Table 3

The Signed Receptive Reading Drill Used in, and Experimental Question of Each of the Seven Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Experimental Question</th>
<th>Signed Receptive Reading Drill</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transfer</td>
<td>Zero Delay</td>
<td>Fingerspell</td>
</tr>
<tr>
<td>2</td>
<td>Transfer</td>
<td>Zero Delay</td>
<td>Fingerspell</td>
</tr>
<tr>
<td>3</td>
<td>Transfer</td>
<td>Zero Delay &amp; Simultaneous</td>
<td>Fingerspell</td>
</tr>
<tr>
<td>4</td>
<td>Transfer</td>
<td>Zero Delay &amp; Simultaneous</td>
<td>Fingerspell</td>
</tr>
<tr>
<td>5</td>
<td>Transfer</td>
<td>Zero Delay</td>
<td>Write</td>
</tr>
<tr>
<td>6</td>
<td>Transfer</td>
<td>Zero Delay</td>
<td>Fingerspell</td>
</tr>
<tr>
<td>7</td>
<td>Transfer</td>
<td>Zero Delay</td>
<td>Write</td>
</tr>
</tbody>
</table>
Spelling modes and spelling generalization were investigated in Experiments 5, 6, and 7. In these last 3 experiments, the zero delay drill was conducted in either writing or fingerspelling, and generalization to the untrained mode was assessed in the posttest.
CHAPTER IV

EXPERIMENTAL RESULTS

Experiment 1

The purpose of Experiment 1 was to determine if transfer occurred when the signed receptive reading procedure was a zero delay drill conducted in the fingerspelling mode.

Method

The words in this experiment were "cake, butter, peach, bread, carrot, cheese, apple, orange, and banana". The picture stimuli for the word sets in both Experiments 1 and 2 were individual, life-size color photographs of the foods (Clymer, 1970). Each photograph was mounted on tagboard and cut to the actual shape of the food. The experimenter held the picture approximately 75 cm from the subject's face when displaying it as the stimulus.

Results

The subject's pretest and posttest scores for each of the eight tasks are presented in Figure 5. The highest possible score was 9. His pretest scores on all of the tasks were partially correct, with his lowest scores being on the reading comprehension, manual reading, and expressive fingerspelling tasks. His high pretest score on the sign comprehension and manual naming tasks indicate that the subject had a verbal history with respect to the words. That is, he could
Figure 5. The number of correct responses on the pretest and posttest in Experiment 1.
already produce and recognize the signs for the common foods in this word set.

Because his score on sign comprehension was perfect during the pretest, it was not necessary to teach this task. Figure 6 shows, for each successive word set trial, the proportion of words with word choice or fingerspelling errors that the subject made during the subsequent zero delay drill. The proportion of words spelled incorrectly decreased gradually from .55 to 0.0 during the 15 word set trials. In contrast, the subject made no word choice errors after the fourth word set trial. These 15 word set trials of the zero delay drill required 4 sessions.

The subject made only one error on the subsequent posttest. As indicated by these gains in the posttest scores of the six untrained tasks, transfer occurred. The reliability of posttest observations was 100%.
Figure 6. The proportion of words with errors during the zero delay drill in Experiment 1.
Experiment 2

In Experiment 1, the subject quickly learned the first two steps in the zero delay drill, those being choosing the printed words corresponding to signed stimuli. The purpose of Experiment 2 was to determine if the subsequent fingerspelling steps in the zero delay drill were necessary. This experiment also replicated the full zero delay drill used in Experiment 1, and assessed transfer to the six untrained tasks.

Method

The words used in this experiment were "tomato, cookie, onion, grapes, cracker, potato, bacon, coffee, and chicken". The subject was initially taught only the first two steps in the zero delay drill. That is, he was taught to select the correct printed word when presented a signed stimulus. The expressive fingerspelling task was administered as a probe of spelling ability as soon as the subject demonstrated that he had learned this by correctly choosing the printed word for each signed stimulus on four consecutive word set trials.

Results

The subject's pretest and posttest scores are presented in Figure 7. The highest possible score was 9. His pretest scores were only partially correct, with his lowest scores being on the expressive and receptive fingerspelling, manual naming, and manual reading tasks.
Figure 7. The number of correct responses on the pretest and posttest in Experiment 2.
His sign comprehension pretest score was perfect, eliminating the need to teach him this task.

As shown in Figure 8, the subject learned the correct printed word for each signed stimulus after 6 word set trials. Table 4 presents the subject's spelled responses on the subsequent expressive fingerspelling probe test. He made multiple spelling errors in 7 of the 9 words, and spelled only one word correctly. These 6 word set trials and probe test took place in 1 session.

Because the subject had not yet learned to fingerspell the words in the set, the zero delay drill used in Experiment 1 was implemented. As shown in Figure 8, this required an additional 25 word set trials, during which the proportion of words spelled incorrectly gradually decreased from .45 to 0.0. These 25 word set trials required 4 sessions.

The subject's performance on six of the posttest tasks was perfect. He made two errors on the expressive and one error on the receptive fingerspelling tasks. Transfer to the untrained tasks did occur. The reliability of posttest observations was 100%.

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Figure 8. The proportion of words with errors during the zero delay drill in Experiment 2.
Table 4
The Subject's Responses on the Expressive Fingerspelling Probe Test in Experiment 2

<table>
<thead>
<tr>
<th>Picture Stimulus</th>
<th>Fingerspelled Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>cookie</td>
<td>cookie</td>
</tr>
<tr>
<td>grapes</td>
<td>cru</td>
</tr>
<tr>
<td>onion</td>
<td>chois</td>
</tr>
<tr>
<td>tomato</td>
<td>tomo</td>
</tr>
<tr>
<td>potato</td>
<td>poto</td>
</tr>
<tr>
<td>bacon</td>
<td>bae</td>
</tr>
<tr>
<td>cracker</td>
<td>cra</td>
</tr>
<tr>
<td>coffee</td>
<td>coffee</td>
</tr>
<tr>
<td>chicken</td>
<td>ches</td>
</tr>
</tbody>
</table>
Experiment 3

The purpose of Experiment 3 was to compare the zero delay drill used in previous experiments with a simultaneous drill. As described previously in Figure 4, the simultaneous drill was a faster procedure in which the subject practiced fingerspelling the word while looking at the printed word. Whereas the subject had to recall the spelling of the word in the zero delay drill, he simply copied its spelling in the simultaneous drill.

Method

The words used in this experiment were "turtle, doctor, pencil, window, horse, rabbit, monkey, turkey, and flower". The picture stimuli were black line drawings on individual yellow cards measuring 15 X 23 cm (Clymer, 1970).

Following the pretest, the words were randomly assigned to either the simultaneous ("turtle, doctor, pencil, window, horse") or zero delay ("rabbit, monkey, turkey, flower") drill. During the drill procedures, the nine signed stimuli were presented in a random order within each word set trial. After each correct printed word choice, the experimenter signed "look and fingerspell" if the word was assigned to the simultaneous drill, and hid the printed word from the subjects view if the word was assigned to the zero delay drill. For both drills, the experimenter recorded whether the subject's first printed word choice and first fingerspelled response were correct or incorrect.
The expressive fingerspelling probe test was administered at the conclusion of each daily session in which these two spelling drills were conducted. The purpose of this probe was to determine if the subject had learned to spell the names of the nine pictures in this word set, thus providing data on the relative effectiveness of the zero delay and simultaneous spelling drills.

**Results**

The subject's pretest and posttest scores are presented in Figure 9. The highest possible score was 9. The high pretest scores indicate that the subject had an extensive prior history with the words in this set. He could not, however, expressively fingerspell any of the words, thus allowing a comparison of the two spelling drills. It was not necessary to teach sign comprehension.

The zero delay and simultaneous drills were taught for 4 sessions, with 4 word set trials in each. The subject's fingerspelling errors during these drills are shown in Figure 10. Word choice errors are not graphed because the subject did not make any. The expressive fingerspelling probe test was administered at the conclusion of each of the 4 sessions. The subject's spelled responses on these probe tests are presented in Table 5.

For the four words taught with the zero delay drill, the proportion of words spelled incorrectly dropped quickly from .5 to 0.0. His spelling of these words during the four probe tests was near perfect, the exception being one incorrect letter in the third probe test.
Figure 9. The number of correct responses on the pretest and posttest in Experiment 3.
Figure 10. The proportions of words fingerspelled wrong during the zero delay and simultaneous drills in Experiment 3.
Table 5
The Subject's Responses on the Expressive Fingerspelling Probe Tests in Experiment 3

<table>
<thead>
<tr>
<th>Word</th>
<th>Probe Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Zero Delay Drill</td>
<td></td>
</tr>
<tr>
<td>Rabbit</td>
<td>*</td>
</tr>
<tr>
<td>Monkey</td>
<td>*</td>
</tr>
<tr>
<td>Turkey</td>
<td>*</td>
</tr>
<tr>
<td>Flower</td>
<td>*</td>
</tr>
<tr>
<td>Simultaneous Drill</td>
<td></td>
</tr>
<tr>
<td>Turtle</td>
<td>turtey</td>
</tr>
<tr>
<td>Doctor</td>
<td>docke</td>
</tr>
<tr>
<td>Pencil</td>
<td>peakey</td>
</tr>
<tr>
<td>Window</td>
<td>wiwi</td>
</tr>
<tr>
<td>Horse</td>
<td>hose</td>
</tr>
</tbody>
</table>

Note. An asterisk (*) indicates a correct fingerspelled response.
With respect to the five words taught with the *simultaneous* drill, the results were the opposite. The subject made only two isolated spelling errors during the 16 word set trials of the drill, yet had not learned to fingerspell the words as indicated by multiple spelling errors in almost all probe test responses.

After the fourth spelling probe test, those words initially assigned to the *simultaneous* drill were trained using the *zero delay* drill for 2 additional sessions. As shown in the bottom half of Figure 10, this represented an additional 15 word set trials during which the proportion of words spelled incorrectly dropped gradually from .4 to 0.0.

The subject's posttest performance was perfect on all tasks. Because his pretest scores had been very high, transfer was seen only in the expressive fingerspelling and manual reading tasks.
Experiment 4

The results of Experiment 3 indicated that the zero delay drill was more effective than the simultaneous drill. Although the subject responded correctly during the simultaneous drill, he had not learned to fingerspell the words as indicated by (a) poor fingerspelling probe test performance, and (b) the errors made when the words were subsequently trained using the zero delay drill. The purpose of Experiment 4 was to replicate the procedures used in Experiment 3.

Method

The words in this experiment were "Georgia, Vermont, Montana, Alabama, New York, Arizona, Wyoming, and Indiana". A black line, state boundary map of the United States provided the picture stimuli. The map measured 22 X 30 cm. The eight states in this word set were colored yellow with a felt tipped pen. To present a picture stimulus, the experimenter pointed to a state with a pencil. The subject likewise pointed to a state when making a response.

Following the pretest, the eight words were randomly assigned to either the simultaneous ("Georgia, Montana, Arizona, Indiana") or zero delay ("Vermont, New York, Alabama, Wyoming") drill. These drills and the spelling probe test procedure were identical to those described in Experiment 3.

Results

The subject's pretest and posttest scores are presented in
Figure 11. The highest possible score was 8. His pretest scores on most tasks were at or below the chance level of accuracy, indicating that the words in this experiment were either less familiar to or more difficult for the subject. The exception was his high pretest score on the signed receptive reading task. This probably occurred because the signs for the states in this word set were "initialized signs". That is, the sign for each state contained the first letter of the state's name. In the experimenter's judgement, the subject understood these clues and was guessing correctly in the signed receptive reading pretest.

Sign comprehension was taught for 4 word set trials. Following this, the zero delay and simultaneous drills were implemented. The proportion of words spelled incorrectly during each drill procedure is shown in Figure 12. No word choice errors were made during either of the drills. The expressive fingerspelling probe test was administered at the conclusion of each session, that is, after 8, 13, and 18 word set trials. The subject's responses on the three expressive fingerspelling probe tests are presented in Table 6.

With respect to the spelling drills and probe tests, the results of this experiment are qualitatively similar to the previous experiment. For those words taught with the zero delay drill, the proportion of words with spelling errors declined gradually from 1.0 to 0.0 during 30 word set trials. His expressive fingerspelling probe test responses for these words were all correct.

In contrast, the subject made no errors during the 18 word set trials of the simultaneous drill. He had not, however, learned to
Figure 11. The number of correct responses on the pretest and posttest in Experiment 4.
Figure 12. The proportions of words fingerspelled wrong during the zero delay and simultaneous drills in Experiment 4.
Table 6
The Subject's Responses on the Expressive Fingerspelling Probe Tests in Experiment 4

<table>
<thead>
<tr>
<th>Word</th>
<th>Probe Test 1</th>
<th>Probe Test 2</th>
<th>Probe Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Delay Drill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>New York</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Alabama</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Wyoming</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Simultaneous Drill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>gom</td>
<td>gea</td>
<td>geid</td>
</tr>
<tr>
<td>Montana</td>
<td>mon</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Arizona</td>
<td>ar</td>
<td>ar</td>
<td>are</td>
</tr>
<tr>
<td>Indiana</td>
<td>ind</td>
<td>ind</td>
<td>ind</td>
</tr>
</tbody>
</table>

Note. An asterisk (*) indicates a correct fingerspelled response.

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fingerspell the words as indicated by his multiple spelling errors in most probe test responses.

After the third spelling probe test, those words initially assigned to the simultaneous drill were trained for 4 additional sessions using the zero delay drill. As shown in Figure 12, there were 20 additional word set trials during which the proportion of words spelled wrong declined from .5 to 0.0.

With the exception of two spelling errors, the subject's performance on all posttest tasks was perfect. This posttest improvement in the six untrained tasks demonstrated transfer. The subject's low pretest scores on this word set made this a more distinct demonstration of transfer than in Experiments 1, 2, and 3. The reliability of pretest and posttest observations was, respectively, 98% and 100.
Experiment 5

In Experiments 3 and 4, the zero delay and simultaneous drills were taught in the fingerspelling mode, with the zero delay drill proven superior. In this experiment, the zero delay drill was conducted in writing; the subject was permitted to fingerspell the words only during the pretest and posttest. The purposes of this experiment were to determine (a) if transfer occurred when a written zero delay drill was used, and (b) if the subject would generalize his spelling ability to the untrained fingerspelling mode.

Method

The words in this experiment were "New Mexico, Minnesota, Wisconsin, Louisiana, Tennessee, and New Jersey". The picture stimuli used Experiments 5, 6, and 7 were the same as those described in Experiment 4. A new map was, however, prepared for each experiment, with only those states in the word set colored yellow. The experimenter prepared small pieces of paper (3 X 7 cm) for use in the written zero delay drill.

All six words in the set were trained using the written zero delay drill. The steps in this drill were identical to the fingerspelling zero delay drill described in previous experiments. The only difference was that in the written version of the drill, the subject took a piece of paper and wrote the word rather than fingerspelling it. He took a new piece of paper for every written response, and was not permitted to look at any of the words he had previously
written.

Results

The subject's pretest and posttest scores are shown in Figure 13. The highest possible score was 6. His scores on most pretest tasks were at or below the chance level of accuracy, demonstrating little prior experience with the words. The exceptions to this were his manual reading and signed receptive reading pretest scores. Because the signs for the states were initialized signs, the subject had learned to guess correctly on these two tasks. The reliability of the pretest and posttest scores was 100%.

Following the pretest, the subject required 10 word set trials on the sign comprehension task. The written zero delay drill was then implemented. As shown in Figure 14, the drill was taught for 19 word set trials. The proportion of words written incorrectly declined rapidly from .825 to .175, and then slowly to 0.0. Again, the subject made no word choice errors. The 19 word set trials of this drill took place during 6 sessions.

The large improvement in posttest performance on the untrained tasks demonstrated transfer. The subject made two errors on the posttest, both of which may be subjectively described as "careless". His perfect posttest score on the expressive fingerspelling task demonstrated generalization from the written to the fingerspelling mode.
Figure 13. The number of correct responses on the pretest and posttest in Experiment 5.
Figure 14. The proportion of words written wrong during the zero delay drill in Experiment 5.
Experiment 6

In Experiment 6, the zero delay drill was conducted in the fingerspelling mode, with the experimental questions being (a) the occurrence of transfer, and (b) spelling generalization to the untrained writing mode. H.O. served as the subject, thus providing an intersubject replication of Experiment 5. The words used in this experiment were "Georgia, Vermont, Montana, Alabama, New York, Arizona, Wyoming, and Indiana".

Results

The subject's pretest and posttest scores are presented in Figure 15. The highest possible score was 8. The reliability of both pretest and posttest observations was 100%. The subject may have had some prior history with the words and states as indicated by his pretest scores on the sign and reading comprehension tasks. His pretest score on signed receptive reading, as in previous experiments, is the result of the clues inherent in initialized signs. His responses on the other four pretest tasks were at the chance level of accuracy.

Sign comprehension was taught for 9 word set trials, after which the zero delay drill was conducted in the fingerspelling mode. As shown in Figure 16, the proportion of words he spelled incorrectly during this drill decreased gradually from .75 to 0.0 during 33 word set trials. The subject made no word choice errors. The 33 trials of the zero delay drill required 6 sessions.
Figure 15. The number of correct responses on the pretest and posttest in Experiment 6.
Figure 16. The proportion of words fingerspelled wrong during the zero delay drill in Experiment 6.
His perfect posttest performance demonstrated complete transfer. Spelling generalization was assessed by having the subject write the name of each picture. The experimenter randomly presented each picture once. The subject's written responses were all spelled correctly, demonstrating generalization from fingerspelling to writing.
Experiment 7

H.O. again served as the subject in Experiment 7. The zero delay drill was conducted in writing, with the experimental questions being (a) transfer, and (b) generalization to the untrained fingerspelling mode. The words in this experiment were "Colorado, Oklahoma, Nebraska, Delaware, Missouri, Kentucky, Illinois, and Virginia".

Results

Figure 17 shows the subject's pretest and posttest scores. The highest possible score was 8. Most of his pretest scores were around the chance level of accuracy. His high pretest score on signed receptive reading again demonstrates correct guesses based on the initialized signs.

Sign comprehension was taught for 15 word set trials. The subject's performance on the subsequent written zero delay drill is shown in Figure 18. He required 25 word set trials, during which the proportion of words spelled incorrectly decreased gradually from 1.0 to 0.0. He made no word choice errors during the drill. The 25 word set trials required 6 sessions.

Posttest performance was perfect on all tasks, demonstrating complete transfer. Generalization to the untrained fingerspelling mode also occurred, as measured by the expressive fingerspelling posttest. An expressive writing test was also given during the posttest. The experimenter presented each sign and each picture and the subject was instructed to write the name of the sign or picture.
Figure 17. The number of correct responses on the pretest and posttest in Experiment 7.
Figure 18. The proportion of words written wrong during the zero delay drill in Experiment 7.
There were no errors in the subject's 16 written responses.
CHAPTER V

DISCUSSION

Experimental Results

The preceding 7 experiments investigated three experimental questions; these being (a) transfer, (b) a comparison of spelling drills, and (c) a comparison of spelling modes and an assessment of spelling generalization. With respect to the first, transfer did occur in each experiment. The subjects were taught only two of the tasks in the sign language mediated transfer paradigm. After learning these two tasks, they responded correctly on the six untrained tasks. In more specific terms, teaching sign comprehension and the zero delay spelling drill enabled the subject to correctly do the manual naming, manual reading, reading comprehension, expressive fingerspelling, and receptive fingerspelling tasks.

With respect to the second experimental question, the zero delay and simultaneous drills were compared in Experiments 3 and 4. The difference between these two drills was whether the subject was required to, respectively, recall or copy the spelling of a word. The zero delay drill proved superior. Although the subject made more errors while learning the zero delay drill, his spelling probe test responses were correct. In contrast, the subject made almost no errors while learning the simultaneous drill, yet had not learned to spell the words as indicated by multiple errors on most probe test responses.
The third experimental question involved a comparison of writing and fingerspelling as spelling modes, and an assessment of spelling generalization from one mode to the other. Experiments 5, 6, and 7 demonstrated that either mode may be used, and that generalization readily occurs. When asked which spelling mode they preferred, both subjects responded "writing". They were then asked why they preferred the written drill. One subject (L.V.) signed "helps remember better". The other subject (H.O.) refused to answer the question.

Comparisons With Sidman's Research

According to Sidman (1977), the critical variable in producing transfer with retarded subjects is the inclusion of all types of stimuli in the two tasks that are taught. This enables the retarded subject to form a 3-member stimulus class consisting of the spoken word, picture, and printed word. In other words, learning to match pictures and printed words to a spoken word (auditory comprehension, auditory receptive reading) produces an equivalence among these three stimuli.

In contrast with Sidman (1971, 1973), the present research used four types of stimuli, these being a signed word, picture, printed word, and fingerspelled word. His explanation of transfer was, however, supported here. The two tasks that were taught (sign comprehension, signed receptive reading) included all four stimuli. As indicated by the deaf subjects' near perfect posttest scores, they did form a 4-member stimulus class for each word. That is, the picture, sign, printed word, and fingerspelled word became equivalent stimuli.
The deaf subjects were then able to spell the names of pictures, match pictures to printed words, and sign the names of pictures and printed words despite the fact that these skills were not directly taught.

As discussed earlier, the development of stimulus classes is a spontaneous process in hearing children who have normal auditory-vocal histories and sounding out skills. They can look at a picture, draw on the auditory history to vocalize its name, and then figure out the spelling of the word using sounding out skills. In a similar manner, they can look at an unknown printed word, sound it out and vocalize it, and then react to the vocalization as a listener to identify the corresponding picture. Transfer is an automatic process for normal hearing children. However, for language impaired persons such as the deaf and retarded, transfer is not an automatic process, and must be specifically engineered.

There were two other differences between this present research and Sidman's (1971, 1973). One difference concerns the paradigms used, and the other is in regard to the differences in the performance and skills of deaf and retarded subjects.

With respect to the first, Sidman used an auditory-vocal paradigm, and this research used a sign language paradigm. The inclusion of spelling skills in the sign language paradigm resulted in (a) two additional pretest and posttest tasks, and (b) a spelling drill during the teaching of signed receptive reading. Spelling was included in the paradigm at the request of local deaf educators. They insisted that the deaf subjects should learn to spell words in addition to
learning to match pictures, printed words, and signs.

With respect to the second, there were several differences in the performance of Sidman’s (1971, 1973) retardates and the deaf subjects. The deaf subjects knew several hundred signs, and could produce and recognize the 26 characters in both the orthographic and fingerspelling alphabets. They both had strong echoic repertoires and readily made echoic responses. As shown in Table 2, explaining the experimental procedures to the deaf subjects required only a few simple signed instructions. For each word set, the pretest, teaching procedures, and posttest were run in less than 2 weeks.

The retardates, on the other hand, had had no academic training prior to the experiments. The profound nature of their retardation made it impossible to verbally explain the experimental procedure. Rather, it took Sidman (1971, 1973, 1974) several months to teach them how to interact with the apparatus and make matching responses. He also had to teach some of his subjects to make vocal echoic responses. Only after these prerequisite skills were taught was Sidman able to actually start the pretest. For each word set, the pretest, teaching procedures, and posttest required many months of daily sessions.

**Implications for Deaf Education**

The paradigm and procedures used throughout this research are well suited to the needs and problems of the deaf for a variety of reasons. The most important of these is that teaching sign comprehension and signed receptive reading provide, respectively, a verbal
history with respect to the words and an alternative to sounding out skills. As discussed previously, these are the two verbal skills which distinguish deaf from hearing students. The only prerequisite skills required by the sign language transfer procedure are a tendency to engage in echoic responses, and the ability to produce and recognize the 26 characters in either the fingerspelling or orthographic alphabets.

The procedural steps of (a) pretest, (b) teach two tasks, and (c) posttest are well suited to the deaf because they are self-paced and individualized. That is, the deaf student learns one word set before progressing to the next word set, thus eliminating the possibility of cumulative failure. Moreover, the procedure is simple enough to be administered by a teacher's aide, parent, or older student.

Another benefit of the transfer approach to teaching reading and spelling to the deaf is that the paradigm is comprehensive and includes all of the skills involved in reading. Teachers of the deaf may use the paradigm as a means of diagnosing specific skill deficiencies. For example, in his work with the profoundly retarded, Sidman (1977) states that if a retardate shows transfer, he may be considered a likely candidate for further reading instruction. If transfer does not occur, the retardate's linguistic capacity may be doubted.

Finally, the transfer procedure may be used with very young deaf children as a method for teaching them vocabulary before exposing them to the more difficult syntax, grammar, and figurative expressions.
Future Research

This present research is the first time Sidman's transfer procedure has been investigated with profoundly deaf subjects. The procedures designed and investigated here need to be systematically replicated by independent investigators. There are four avenues for future research.

The first concerns the subjects. Mildly retarded deaf adolescents were used in this research. The procedures should be replicated using deaf subjects of differing ages and intelligence. Of particular interest would be a replication using very young deaf children of normal intelligence. An attempt could be made to determine the earliest age at which transfer occurs.

The second line of future research concerns the two teaching tasks. In a systematic replication of Sidman's (1971, 1973) procedure, sign comprehension and signed receptive reading were the two tasks taught during the preceding experiments. Different combinations of teaching tasks should be investigated, such as sign comprehension and one of the reading comprehension tasks. Sidman (1974) found that this combination produced transfer in retarded subjects. These two teaching tasks should be replicated with deaf subjects.

A third line of future research should determine whether the inclusion of all types of stimuli in the two teaching tasks is necessary for the occurrence of transfer. The present experiments did include all four stimuli in the teaching tasks. Future research should be conducted in which only some of these stimuli are included.
in the two tasks that are taught.

A final line of future research concerns the zero delay and simultaneous spelling drills. Although the fingerspelling simultaneous drill used in this research was unsuccessful, a written simultaneous drill was not investigated. When deaf persons of normal intelligence are used as subjects, the results of these two drill procedures may or may not differ from the results found here with mildly retarded deaf subjects.
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