Nonverbal Coding in Deaf Children

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NONVERBAL CODING IN DEAF CHILDREN

by

William J. White

A Dissertation Submitted to the Faculty of the Graduate School of Loyola University in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

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The author was born in Chicago, Illinois, on October 13, 1943. After graduating from Holy Cross Seminary, Notre Dame, Indiana in June of 1961, he entered St. Procopius College, Lisle, Illinois in September of 1962 and transferred to Loyola University of Chicago in September of 1963. He was awarded the Bachelor of Science degree by Loyola in June of 1966 and immediately entered the graduate program in clinical psychology at that institution. He was awarded the Master of Arts degree in February of 1969 and is currently a candidate for the degree of Doctor of Philosophy.

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Although theoretical analyses of thinking or cognitive processes have traditionally considered language to be of central importance, recent formulations have suggested that thinking and language are relatively independent processes. Empirical support for these formulations has been derived from several different areas of research endeavor. One of the most striking has been research on the thinking processes of the deaf. If the deaf, a language deficient population, perform similarly to the hearing on tasks considered to be language dependent, then the necessity of language competence for cognitive competence is seriously called into question.

The influence of language on thinking has been considered to occur at at least two levels. First, at the semantic level, the labelling function of language has been considered of primary importance in coding-recoding operations which are seen as influential in perceptual processes and in storage and retrieval processes. Secondly, at the syntactical level, the underlying structures of language have been considered to influence the nature and form of the logical operations which are necessary for certain kinds of problem solving. While both levels have been considered in the theoretical analyses arising from research with the deaf, this paper will consider only the first level, labelling.

A number of authors have suggested that nonverbal coding processes
may account for the performance of the deaf on certain tasks. These processes are considered either as parallel processes to verbal coding operations in the hearing or as products of a more central coding operator with both verbal and nonverbal products. Neither hypothesis, as generally stated, denies the sufficiency of verbal or linguistic processes for a hearing population but only their necessity for a language deficient population.

An appropriate test of these hypothetical systems would have to involve a task which, while not directly measuring verbal ability, nevertheless is dependent on verbal abilities. This requirement would be fulfilled by any number of the tasks which, on either theoretical or empirical grounds, are considered to require or to be facilitated by the operation of verbal mediators. One such task is visual discrimination learning in young children, a particularly useful task because of the considerable empirical documentation of the effects of verbal mediators on performance. By using such a task and appropriately manipulating the availability of verbal mediators, the effects of the hypothetical nonverbal coding system should be evidenced in a comparison of the performance of deaf and hearing children.
CHAPTER II
REVIEW OF THE LITERATURE

If the foregoing analysis is to be given serious consideration, certain of the underlying assumptions made need to be examined in the light of the available empirical data. These assumptions are: 1) the deaf do in fact constitute a language deficient population; 2) sufficient evidence exists to warrant the postulation of a nonverbal coding system; and 3) the effects of verbal mediators in visual discrimination learning are sufficiently documented to warrant the use of this task for the purposes suggested.

With regard to the first assumption, the term deaf, as used in this paper, is intended to refer to the prelingually deaf and not to those individuals adventitiously deafened after the attainment of some degree of linguistic competence. While such a distinction would seem rather obvious, it is unfortunately the case that much of the clinical research in deafness fails to make it (or at least to report it), thereby confusing to some extent the interpretation of the findings.

The fact that the deaf do indeed constitute a language deficient population can be demonstrated in several ways, depending on the preferred definition of language. At the simplest level, the inability of the deaf (with a few notable exceptions) to either transmit or receive speech can be said to indicate language deficiency since speech constitutes the bulk of language activity for most people. This is, in essence, the position advanced by Furth (1964, 1966, 1970).
Such a definition of language competence would appear to be unduly restrictive, however, since it neglects other language systems such as reading and writing. A number of interrelated studies by a group from Vanderbilt University provide more convincing evidence of the language deficiency of the deaf (Blanton, 1968). Using a number of verbal techniques adapted to use with the deaf, these investigators found both qualitative differences and retardation in the language performance of the deaf by comparison with hearing controls matched for chronological age and for reading level. Two aspects of their findings seem particularly salient. First, the fact that the language of the deaf subjects was largely reproductive rather than generative suggests the likelihood that the deaf individual will be rather rigid in the application of language and therefore lack the flexibility required for certain kinds of problem solving. That is, his ability to generate hypotheses about novel situations would be restricted to the extent that this aspect of language competence is relevant to problem solving. Further, his solutions would be less likely to be correct to the extent that the given situation differed from previously encountered situations. Even at the level of coding, the deaf individual's ability to utilize those labels available to him would be dependent on specific training. Secondly, the finding that certain syntactical elements of language (e.g., function words and word order) are poorly utilized by the deaf suggests that the deaf would be unable to draw upon certain of the structuring aspects of language. The findings of this group indicate that the deaf constitute a language
deficient population at both the semantic and the syntactical levels.

Perhaps the most striking evidence of the deficient language performance of the deaf is provided by a normative study by Wrightstone, Aronow, and Moskowitz (1963). The authors were attempting to provide norms for the reading skill of the deaf without reference to hearing norms. Furth (1970), however, compared their findings to the national norms for the normal population. He found that the average reading level of the oldest group of deaf Ss (CA 15.5-16.5) was at Grade 3.6. As Furth points out, this level is so low as to be indicative of functional illiteracy and consequently is a clearcut indication of language deficiency in precisely the area where the deaf might be expected to demonstrate their greatest proficiency. Vernon and Rothstein (1968) cite these same findings as well as the well-documented failure of the deaf on tests of verbal intelligence (Hiskey, 1956, Myklebust, 1960) to support their contention that the deaf constitute a "natural experiment" in language deficiency.

Two objections may be raised in regard to the applicability of these findings to the proposed study. First, it might be argued that the deficiencies noted were primarily at the syntactical rather than the semantic level. While the deficits at the syntactical level were perhaps more striking, the research of the Vanderbilt group clearly indicated deficits at the semantic level as well. Further, the use of very young subjects, hence subjects with extremely limited exposure to formal language systems, should further insure deficiency at the level of coding.
The second point considers the effect of the manual communication system, especially as it might provide a compensatory mechanism at the level of coding. Recent research (Meadows, 1968) has in fact indicated that early exposure to manual communication has rather complex effects on the functioning of deaf children in several developmental areas. To avoid these possible confounds, subjects for the proposed study would be drawn only from so-called "oral" classrooms where the manual communication system is not only not taught but actively discouraged. It would seem, then, that it is reasonable to assume that the proposed subjects of this study do indeed constitute a language deficient population.

Support for the second assumption, the existence of the nonverbal coding system, derives from several sources. First, one may consider the theoretical positions emphasizing the independence of language and thinking. Secondly, there is indirect research support such as studies demonstrating equivalent performances of language deficient and language proficient populations on supposedly language dependent tasks. Thirdly, a number of authors have, on a post hoc basis, hypothesized a nonverbal coding system as an explanatory principle for their findings. Finally, there is one study which directly tested hypotheses derived a priori from the positing of such a system.

The principal theoretical support for the independence of language and thinking is derived from the works of Piaget (1955, 1967, Ginsburg and Opper, 1969) and Vygotsky (1962). Neither sees thinking as ultimately independent of language. Their emphasis is rather on the independent
development of the two processes. Thus, although both men view the two processes as eventually interactive, the fact that they stress the initial independence of the processes and, especially, their independent development is of importance to the contention that they may remain independent processes.

In the Piagetian analysis of cognitive development, the emphasis on very early development precludes any influence of language in the initial stages. Since the sensorimotor stages of development take place during the first twelve to eighteen months of life, the foundations of cognitive processes are laid down essentially free of the influence of language. Piaget claims further that during the next stage of development, the stage of concrete operations, the tremendous growth of linguistic competence has little effect on the cognitive performance of the individual. That is, the individual during this stage is more or less incapable of utilizing his increasingly sophisticated linguistic ability to structure his interactions with the environment. Thus, at least during the first five or so years of life, Piaget views the development of language and thinking as independent though convergent processes.

Vygotsky, considering the evidence from research with subhuman species as well as developmental studies with humans, states unequivocally that language and thought have different roots and different lines of development. Discussing the phylogenesis of speech and thought, Vygotsky presents these conclusions, among others:

1) Thought and speech have different genetic roots.
2) The two functions develop along different lines and independently of each other.
3). There is no clearcut and constant correlation between them...
6). In the phylogeny of thought and speech, a prelinguistic phase in the development of thought and a preintellectual phase in the development of speech are clearly discernible (1962, p. 41).

Discussing their ontogenesis, he states:

"1). In their ontogenetic development, thought and speech have different roots.
2). In the speech development of the child, we can with certainty establish a preintellectual stage and in his thought development, a prelinguistic stage.
3). Up to a certain point in time, the two follow different lines, independently of each other (p. 44)."

It is true that Vygotsky notes a close correspondence between speech and thought in man and assigns an important role to language in the development of thought beyond that "certain point in time" referred to above. Even within such a framework, however, he nevertheless states, "We are...forced to conclude that fusion of thought and speech, in adults as well as in children, is a phenomenon limited to a circumscribed area (p. 48)." Again, the most important point is the initial independence of thought and language and their initially independent development.

Neither of these theories, of course, necessitates the positing of a nonverbal coding system. They can, however, be so interpreted as to give rise to questions which eventuate in the positing of such a system. For example, what is the "medium" of thought prior to linguistic influence? That is, what is the mediating symbol system of thought prior to the availability of verbal symbols? If the development of
thought initially proceeds independently of the influence of language, might it not continue to develop without that influence? Finally, might not the preverbal (hence nonverbal) mediating system continue to be operative in the absence of linguistic input and serve the same functions as language? The first question, especially as it applies to infants, is probably a philosophical rather than a scientific one but there is some evidence that the answers to the second and, at least in part, the third are positive.

Several extensive reviews of the literature with regard to the performance of the deaf on various tasks are available and in each instance the reviewer draws conclusions supporting the hypothesis of no necessary connection between language ability and cognitive ability. Rosenstein (1961) focused on concept formation and usage tasks and reached the conclusion that the performance of the deaf was equivalent to the performance of the hearing providing the task did not directly involve the use of language. Vernon (1967) reviewed the performance of the deaf on nonverbal measures of intelligence, arguing that such measures are most closely related to what is commonly called thinking or cognitive ability. Noting that the performance of the deaf on such measures was quite equivalent to the performance of the hearing, Vernon made the following conclusions:

"1). There is no functional relationship between verbal language and cognition and thought processes.  
2). Verbal language is not the mediating symbol system of thought.  
3). There is no relationship between concept formation, and level of verbal language development (p. 332)."
These are obviously extreme statements and, in fact, the evidence which he presented does not support them. There is sufficient support, however, for the contention that the relationships mentioned are not necessary. The most extensive reviews, covering a wide variety of tasks which can be considered indicative of cognitive competence, are provided by Furth (1964, 1966, 1970). His conclusions are similar to Vernon's though not so strongly stated. He also attempts to provide an alternative theory of the thought process in his book *Thinking Without Language* (1966). Taking Piaget's theory as a starting point, Furth argues that symbolic behavior rather than linguistic behavior is the hallmark of intelligence and suggests the possibility that symbols may have forms other than verbal, for example, visual or kinesthetic.

A number of studies have dealt specifically with tasks which have been considered to be dependent on a certain degree of linguistic competence and have demonstrated equivalent performances of language deficient (deaf) and language proficient (hearing) subjects. These include concept formation of the Bruner type (Kates, Yudin, and Tiffany, 1962, Rosenstein, 1960); abstracting ability (Furth, 1963b); reversal shift (Youniss, 1964); and complex problem solving requiring discovery of the underlying logical structure of the problem using an adaptation of the Rimoldi problems (Vander Woude, undated). Also, Pufall and Furth (1966) and McCarthy and Marshall (1969) have demonstrated that deaf children, though slower than hearing controls matched for CA, are capable of learning a double alternation task. This last task has been considered strongly language dependent since neither very young children
nor subhuman species are capable of learning the proper sequences. It would seem, then, that a variety of tasks which have been considered to require the mediation of a verbal symbol system can be successfully accomplished by a language deficient population.

Those investigators who have attempted to account for such findings have typically posited a nonverbal mediation system which serves the same function as verbal mediation in the hearing. Furth's hypothesis, noted above, can be considered in this category. Andre (1964, 1969) demonstrated equivalent performance of deaf and hearing children on a reversal shift task. He suggested that mediation was operative in both groups but that mediation "is due to some symbolic system (not necessarily verbal) which is verbal in hearing children but something else in deaf children." Chovan (1970), investigating memory function, reached essentially the same conclusion. Pettifor (1968) demonstrated that despite a relative increase in degree of language deficiency with increased chronological age, deaf children maintained their relative position with regard to hearing children in conceptual ability. He suggested a nonlanguage coding system as a possible explanation of his findings. Weigl and Metze (1970) demonstrated that deaf children were capable, to some degree, of discovering and utilizing even linguistically determined concepts (extreme values). They interpreted their findings as supporting the possibility of nonverbal forms of coding and recoding of logical-mathematical relationships.

Pascual-Leone and Smith (1969) addressed themselves to the nature of the encoding-decoding mechanism in children. They postulated an
"M operator," similar to the Central Computing Space of Miller and Chomsky, and pointed out that it does not make sense to speak of M as verbal or linguistic since M belongs to a higher logical order than its linguistic product and hence will operate equally well in non-linguistic contexts. Like Furth, they drew on Piagetian formulations in the construction of their theory and pointed out that linguistic competence is a consequence of cognitive competence. They compared hypotheses derived from their model to hypotheses derived from Bruner's theory of levels of representation and the results supported their predictions. Following Piaget, the authors also derived a logico-mathematical model based on their theory and the results of the study. Applying the conventions of symbolic logic to this model, they were able to successfully postdict the results of certain Piagetian conservation tasks and the findings of the Kendlers on reversal shift tasks.

Finally, it is interesting to note that at least one author has reached a similar conclusion but did so deriving his support from a completely different line of research. Pikas (1966), after extensively reviewing both classical and modern theory and research in abstraction and concept formation, concluded that coding-recoding operations are of central importance in abstraction and concept formation but insisted that coding-recoding need not be verbal. There is, therefore, suggestive evidence at least, both theoretical and empirical, as well as the more direct evidence of Pascual-Leone and Smith, to support the hypothesis of a nonverbal coding system in the deaf.

With regard to the last assumption, the appropriateness of the
visual discrimination learning task as a test of the hypothetical system, there is a considerable body of research which has been summarized by Spiker (1957, 1963). The basic form of the studies in this area has been to compare the performance of a group of subjects who received preliminary training involving the arbitrary assignment of discriminative verbal labels to visual stimuli with the performance of various appropriate control groups. The combined results indicate that the provision of verbal labels does indeed facilitate learning and that this facilitation cannot be ascribed to warmup effects, amount of exposure to the relevant stimuli, simple discrimination training, etc., at least in young children. In Spiker's words, "Apparently, there is something about the learning of names, per se, that results in the subsequent facilitation. (1963, p. 59)." Spiker favors the "acquired distinctiveness of cues hypothesis (i.e., the making of distinctive responses to stimuli produces distinctive stimuli which become parts of the relevant stimulus complexes) to explain these findings. Arnoult (1957), however, in reviewing the larger area of stimulus predifferentiation, of which Spiker's work may be considered a subset, concluded that no adequate theoretical explanation was available despite the consistent demonstration of the facilitating effects of predifferentiation. Regardless of the theoretical explanation one prefers, however, it seems firmly established that the provision of verbal mediators does indeed facilitate visual discrimination learning in young children. It is also of interest to note that Jeffrey (1953) has demonstrated that responses other than verbal responses, in this instance motor responses, can serve as
mediators in tasks of this type.

It would seem, then, that the assumptions underlying the proposed study are reasonable and we may proceed to outline an investigation of the hypothetical nonverbal coding system. Specifically, it is proposed that the prelingually deaf code visual stimuli nonverbally and that these nonverbal responses can and do serve as discriminative stimuli for the deaf in the same fashion that verbal labels serve as discriminative stimuli for the hearing. On a visual discrimination task utilizing stimuli with readily available verbal labels, then, the performance of deaf and hearing subjects should not be significantly different. If verbal labels were not readily available, however, the performance of the hearing subjects would be significantly inferior to that of the deaf. This disparity would depend on the fact that for the deaf both situations would involve the same mediational system while for the hearing the first situation would call into play a well-established and highly practiced mediational system while the second situation would either be non-productive of mediators or require the use of a mediational system which the subjects were not accustomed to using.

Several methods are available for manipulating the availability of verbal labels but the least susceptible to extra-experimental confounding involves the use of preexistent labels. That is, for the "verbal labels available" condition, common shapes, for which the hearing child could reasonably be presumed to have acquired labels, would be utilized. For the "verbal labels not available" condition, random or "nonsense" shapes of low association value would be employed. Such a design, of course,
necessitates some provision for the demonstration that the presumed availability (or nonavailability) of labels was in fact the case.

No directly comparable study was found in the literature; however, several studies with some degree of relevance have been reported. Putnam, Iscoe, and Young (1962) and Chovan (1970) reported studies on the influence of m (meaningfulness) on the verbal learning of deaf subjects. Since association value is the usual measure of m, their findings have some bearing. In both studies, a facilitating effect of high m was found, raising the possibility of a differential performance by the deaf subjects in the high association value (verbal labels available) condition versus the low association value (verbal labels not available) condition. Such a difference might be expected because of the differential pre-experimental exposure to the relevant figures but this difference would not be crucial to the hypothesis in question since the critical index is between the deaf and hearing subjects and not within either group.

Two studies were reported, however, which suggest the possibility that the predicted advantage for the deaf subjects might not be found. In the first, Olsson and Furth (1966) compared the effects of high and low association value nonsense figures on the visual memory span of deaf and hearing adolescents and adults. They found that both groups were similarly affected by level of association value. They suggested, however, that degree of similarity to familiar figures was the relevant variable rather than availability of labels. Because this study differs in several respects from the present study, the exact relevance of these
findings is difficult to determine. First, the subjects of Olsson and Furth were adolescents and adults and stimulus predifferentiation effects are less consistent in older subjects (Arnoult, 1957). Secondly, the task employed was quite different in nature. Finally, it can also be pointed out that the availability of labels was not well controlled in the Olsson and Furth study.

In the second study, Oleron and Gumusyan (cited in Furth, 1970) compared deaf and hearing children, ages 4-6, on an embedded figures test employing both meaningful—hence nameable—figures and geometric shapes for which names were not available. A consistent inferiority of the deaf children was noted for both categories although the difference was statistically significant only for the five-year-olds on the meaningful figures.

The findings of these two studies suggest the possibility that the deaf subjects might in fact perform more poorly in both proposed categories. Particularly, they suggest that the predicted advantage in the "verbal labels not available" condition might not be found. In light of the other evidence, however, and in light of the differences between these studies and the proposed study in terms of subjects and relevant task, they do not seem to constitute sufficient evidence to warrant abandonment of the proposed study.
CHAPTER III

METHOD

Subjects: Two groups of Ss were utilized. The first consisted of 16 severely to profoundly deaf boys. These constituted the male population of one preschool deaf class and three primary deaf classes located in three public schools in the northwest suburban area of Chicago. Four other pupils in these classes were excluded from the sample, two because hearing loss was not of sufficient degree, one because of the presence of other physical involvement, and one because his parents refused permission for his participation. Of the boys included, only one demonstrated an evident physical problem beyond the hearing loss, namely cerebral palsy restricted to involvement of the lower limbs. Ss ranged in age from 5-9 to 8-7 with a mean CA of approximately 6-10. Age at onset of hearing loss was given as birth for 10 Ss, by 9 months for 1, and was not noted for the other 5. Cause was given as maternal rubella for 5, probable maternal rubella for 2, congenital for 2, and was not noted for the other 7.

A second group was selected from the first three grades at a parochial grammar school in the same geographical area. They were matched to the deaf group primarily on the basis of chronological age with rough approximations of family socioeconomic status, based on father's occupation, where such data were available. With regard to the first variable, the hearing group ranged in age from 5-8 to 8-7 with a mean CA of approximately 6-10. With regard to the second variable, data were not always available and most of the matches made were approximate. Overall, the samples were quite comparable on this variable although
weighted toward the upper end of the socioeconomic scale with a disproportionate number of white-collar and professional workers as heads of household.

Apparatus: For the pretest phase, a standard Leiter frame and Leiter blocks were employed with a special stimulus card and comparison figures consisting of solid black representations of an expanded cross, circle, five-point star, equilateral triangle, square, and diamond from left to right on the stimulus card. The figures were standard Leiter size, approximately 3/4 inches high.

For the procedure proper, two 3 inch square box lids were mounted on posts affixed to a plain brown board of composition material approximately 16 inches in width and 11 inches in depth. The boxes were centered on the board with respect to its depth and approximately 2 and 1/2 inches from the outer edge of the board to the outer edge of the box. They were so mounted as to be easily lifted and replaced and were secured in position by small posts diagonally opposed at two corners. The boxes were approximately 1/2 inch in height and were fitted with clear plastic coverings arranged so that the stimulus cards could be affixed underneath and be both easily seen and protected from soiling and damage due to handling. The top surface of one box was white and the other black; the tops were visible when no stimulus card was inserted.

The stimulus materials consisted of 6 pairs of 3 inch square white cards with the stimulus figures in solid black approximately 2 inches high (Height of the figure varied slightly for the random shapes.). The cards were prepared by a photocopying procedure. Three of the pairs
consisted of the common regular shapes used in the pretest and paired as follows: circle-square, diamond-triangle, and cross-star. The remaining pairs consisted of random shapes selected from the Vanderplas and Garvin (1959) tables for low association value (below .28) and intrapair similarity. (See Appendix A for reproductions of the stimulus materials.)

Red, white, and blue poker chips were used as reinforcers; no significance was attached to the colors. At the end of the session, the accumulated chips were exchanged for a small toy car.

**Procedure:** The procedure was totally nonverbal for both groups. The hearing Ss were simply told, "We have one special rule. There will be no talking once we start." Ss were tested individually in a private room. They were seated across from E at tables of comfortable height for children of their age. All Ss were first presented with the Leiter frame with the stimulus card affixed and the special Leiter blocks were then presented one at a time in random order. Most Ss immediately began placing the blocks in the frame; for the few who did not, a simple pointing to the frame and questioning look sufficed to initiate the desired behavior. All Ss easily passed the pretest.

After the pretest the Leiter frame was removed and replaced by the test board with the two boxes affixed but no stimulus card inserted. A poker chip was placed under one of the boxes in full view of the S. Several seconds were allowed to elapse and E indicated by gesture that S should find the chip. If S merely pointed to a box, E indicated by gesture that he should lift the box of his choice. If the choice was
incorrect, E lifted the other box and pointed out the chip, repeating
the procedure until S made a correct choice. (In no case did this
require more than 3 trials.) When S made a correct choice, E indicated
that S should take the chip which he had found. Two more trials were
then given with the box in the same position and two with the position
of the box switched. The board was then tilted so that the boxes were
not visible to S and a chip was hidden out of his sight. The board was
then re-presented and S allowed to choose one box. Again, if an incorrect
choice was made, E lifted the correct box and called S's attention to the
chip. Several trials of this nature were given and then the procedure
proper began. Throughout this familiarization procedure, the same box
was always reinforced with the white and black being alternately
reinforced for alternate Ss.

The experiment proper was conducted in the same fashion as the final
portion of the familiarization procedure except that no further inform-
ation was given following incorrect choices. One pair of stimulus
cards was affixed to the boxes, the board was tilted, and a chip hidden
out of S's sight. The board was then re-presented and S made his choice.
Trials with one pair of stimuli were not interspersed with trials on any
other; once a stimulus pair was introduced, trials with that pair
continued to a criterion of 10 consecutive correct responses or 50
trials, whichever came first. The order of presentation of the pairs
was randomly determined for each S with the exception that the circle-
square pair was always presented first. The position of the reinforced
member of the pair was randomly varied and the member of the pair
reinforced was alternated with alternate Ss.

Finally, a debriefing was conducted for the hearing Ss. The stimulus cards were re-presented one at a time and the S was asked, "What is this? What do you call it?" Responses were recorded verbatim. Deaf Ss were also given an opportunity to respond but if no discriminable verbal responses were given to the regular shapes, the random shapes were not presented.
CHAPTER IV

RESULTS

Although the results of the debriefing procedure indicate that the assumptions regarding codeability of the figures were valid, the predicted differences in performance were not found. The hearing Ss demonstrated consistently superior performance but the difference was not statistically significant. The only significant finding was a main effect of pairs in the "verbal labels not available" condition.

Table 1 presents a summary of an analysis of variance treating the study as a 2X2 repeated measures design. Hearing Status refers to membership in the deaf or hearing group while Codability refers to the availability of labels with High Codable referring to the "verbal labels available" condition and Low Codable to the "verbal labels not available" condition. None of the comparisons are significant although the main effect of Hearing Status approaches significance at the .10 level.

Inspection of the data suggested that a test for the effects of individual stimulus pairs was in order. Since the total group of pairs cannot be considered as random effects nested within Codability, separate analyses were necessary for each level of Codability. Summaries of these analyses are presented in Tables 2 and 3. These analyses treat each level of Codability as a separate 2X3 repeated measures experiment. No comparisons are significant for the High Codability condition although the main effect of Hearing Status again approaches significance at the .10 level. A significant main effect of Pairs is found in the Low
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<td>A (Hearing Status)</td>
<td>5,347.27</td>
<td>1</td>
<td>5347.27</td>
<td>2.39</td>
</tr>
<tr>
<td>S w. groups</td>
<td>67,194.97</td>
<td>30</td>
<td>2239.83</td>
<td></td>
</tr>
<tr>
<td><strong>Within S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (Codability)</td>
<td>228.77</td>
<td>1</td>
<td>228.77</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>17.01</td>
<td>1</td>
<td>17.01</td>
<td></td>
</tr>
<tr>
<td>B x S w. groups</td>
<td>16,762.72</td>
<td>30</td>
<td>558.76</td>
<td></td>
</tr>
</tbody>
</table>

a. nonsignificant
TABLE 2

Summary of Analysis of Variance
Hearing Status X Pairs
High Codable Stimulus Pairs

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (Hearing Status)</td>
<td>11,470.00</td>
<td>31</td>
<td>793.50</td>
<td>2.23 a</td>
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<tr>
<td>S w. groups</td>
<td>10,676.50</td>
<td>30</td>
<td>355.88</td>
<td></td>
</tr>
<tr>
<td><strong>Within S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (Pairs)</td>
<td>9,367.33</td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>153.58</td>
<td>2</td>
<td>76.79</td>
<td></td>
</tr>
<tr>
<td>B x S w. groups</td>
<td>214.75</td>
<td>2</td>
<td>107.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8,999.00</td>
<td>60</td>
<td>149.98</td>
<td></td>
</tr>
</tbody>
</table>

'a. nonsignificant
TABLE 3

Summary of Analysis of Variance
Hearing Status X Pairs
Low Codable Stimulus Pairs

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (Hearing Status)</td>
<td>18,303.99</td>
<td>31</td>
<td>994.60</td>
<td>1.72  a</td>
</tr>
<tr>
<td>S w. groups</td>
<td>17,309.39</td>
<td>30</td>
<td>576.98</td>
<td></td>
</tr>
<tr>
<td>Within S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (Pairs)</td>
<td>7,548.67</td>
<td>64</td>
<td>301.04</td>
<td>2.64  b</td>
</tr>
<tr>
<td>AB</td>
<td>98.68</td>
<td>2</td>
<td>49.34</td>
<td></td>
</tr>
<tr>
<td>B x S w. groups</td>
<td>6,847.92</td>
<td>60</td>
<td>114.13</td>
<td></td>
</tr>
</tbody>
</table>

a. nonsignificant
b. significant at .10 level
Codability condition. Application of the Newman-Keuls procedure for comparisons between all possible pairs of means indicates that the mean performance on pair 4 is significantly different from the mean performance on pair 2. No other comparisons are statistically significant.

Since the age range of Ss utilized was greater than anticipated a priori, some analysis of the effect of age on performance seemed in order. Rank-order correlation coefficients were computed. Since the two groups had been matched for age, separate analyses were done to avoid attenuation of the age variable. The rank-order correlation coefficients were small and nonsignificant ($r_{\text{Hearing}} = -0.16$, $r_{\text{Deaf}} = 0.34$).

The results of the debriefing for the Hearing Ss are presented in Table 4. Included in the "Don't Know" category for each of the random shapes is one response of, "A shape," which was given indiscriminately to each of the random shapes by one of the Ss.

Finally, the results of the debriefing for the Deaf Ss are presented in Table 5. The criterion utilized in deciding whether or not a "label" was available for a given shape was that a recognizable sound was used to identify that shape and that the sound was clearly discriminable from the "labels" for other shapes. The latter condition was necessitated by the fact that a number of the Deaf Ss at first seemed to have a label for a particular shape but then proceeded to use essentially the same sound to identify the other shapes as well. None of the Deaf Ss provided a discriminable label for any of the random shapes.
TABLE 4

Figure Identification
Hearing Subjects (N=16)

<table>
<thead>
<tr>
<th>Figure</th>
<th>Response (No.)</th>
<th>Figure</th>
<th>Response (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. (Circle)</td>
<td>Circle (16)</td>
<td>4A.</td>
<td>Don't Know (13)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indian (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Monster (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rectangle (1)</td>
</tr>
<tr>
<td>1B. (Square)</td>
<td>Square (15)</td>
<td>4B.</td>
<td>Don't Know (12)</td>
</tr>
<tr>
<td></td>
<td>Triangle (1)</td>
<td></td>
<td>Flag (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Witch (1)</td>
</tr>
<tr>
<td>2A.</td>
<td>Don't Know (13)</td>
<td>5A. (Cross)</td>
<td>Cross (13)</td>
</tr>
<tr>
<td></td>
<td>House (1)</td>
<td></td>
<td>Don't Know (2)</td>
</tr>
<tr>
<td></td>
<td>Harpoon (1)</td>
<td></td>
<td>&quot;X&quot; (1)</td>
</tr>
<tr>
<td></td>
<td>Arrow (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B.</td>
<td>Don't Know (8)</td>
<td>5B. (Star)</td>
<td>Star (16)</td>
</tr>
<tr>
<td></td>
<td>House (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triangle (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A. (Diamond)</td>
<td>Diamond (14)</td>
<td>6A.</td>
<td>Don't Know (12)</td>
</tr>
<tr>
<td></td>
<td>Square (1)</td>
<td></td>
<td>Pants (1)</td>
</tr>
<tr>
<td></td>
<td>Don't Know (1)</td>
<td></td>
<td>Bridge (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;Y&quot; (1)</td>
</tr>
<tr>
<td>3B. (Triangle)</td>
<td>Triangle (13)</td>
<td></td>
<td>Somebody walking (1)</td>
</tr>
<tr>
<td></td>
<td>Rectangle (3)</td>
<td>6B.</td>
<td>Don't Know (13)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Triangle (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Legs (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Table with broken legs (1)</td>
</tr>
</tbody>
</table>

-27-
TABLE 5
Figure Identification
Deaf Subjects (N=16)

<table>
<thead>
<tr>
<th>Figure</th>
<th>No. of Labels (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle</td>
<td>3</td>
</tr>
<tr>
<td>Square</td>
<td>3</td>
</tr>
<tr>
<td>Triangle</td>
<td>3</td>
</tr>
<tr>
<td>Diamond</td>
<td>0</td>
</tr>
<tr>
<td>Star</td>
<td>3</td>
</tr>
<tr>
<td>Cross</td>
<td>2</td>
</tr>
</tbody>
</table>

a. No. of labels refers to the number of Ss able to provide a label for the relevant figure with label defined as identification of the shape by a recognizable sound which was clearly discriminate from sounds used to identify other shapes.
Examination of the results of the various analyses clearly indicates that the predicted advantage for the Deaf Ss was not found. In fact, the performance of the Hearing Ss was consistently superior, though not at a statistically significant level. The failure of these differences to reach statistically significant levels is in part an artifact of the design. The arbitrary ceiling imposed by the conditions of the design tended to minimize the differences between good and poor performances. Many of the Deaf (and some of the Hearing) Ss reached the cutoff point of 50 trials clearly unaware of the correct choice for the relevant stimulus pair. Had they been allowed to continue, their poor performance would have been more adequately represented by higher scores.

It is of interest to note that the performance of the Deaf Ss, especially in the Low Codability condition, was notably heterogeneous. The distribution of their scores was essentially bimodal, clustering toward the extremes of the available range. That is, for the Deaf Ss, the tendency was to perform at optimal or near optimal levels or to be unable to learn the appropriate discrimination. For the Hearing Ss, a more normal distribution was obtained although it was skewed somewhat toward the good performance side.

Examination of Tables 4 and 5 indicates that the assumptions regarding the availability of labels were essentially correct. Both the implicit assumption that the deaf would lack labels for all figures and the explicit assumption that the hearing would have labels available differentially are confirmed although one of the random shapes, 2B,
elicited more labels than would have been expected. Although the difference between the levels of Codability was generally in the expected direction, the effects of this variable were not as pronounced as had been expected. It is of interest to note that Pair 4 was both most difficult to learn and least productive of labels but the overall performance of the two groups suggests that ease of learning and availability of labels were not causally related but rather were covariants depending on the operation of some underlying variable such as stimulus complexity or familiarity. The Hearing Ss were at the upper limit of or slightly beyond the optimal age for the facilitating effects of verbal mediators in the visual discrimination learning task and the full effects of this variable may not have been operative.

Several possible explanations for the observed superiority of the Hearing Ss seem possible. The simplest explanation is that the results are contaminated because deafness is an interdependent rather than an independent variable. Vernon and Rothstein (1968) point out that the differences obtained in comparisons of deaf and hearing samples may not be due to the fact of deafness per se but rather to such variables as parental reaction to deafness or the higher incidence of neurological involvement in the deaf. The latter point may be particularly significant in respect to the present study. Although, as noted above, no evident organic dysfunctions other than the deafness were noted, the high incidence of maternal rubella as cause of deafness in this sample raises at least the possibility of other more subtle neurological impairments. Such impairments is some proportion of the deaf sample,
taking the form perhaps of disturbance in attention span or visual-perceptual handicap, might explain the bimodal distribution of the Deaf Ss.

A second possible explanation refers to the educational strategies employed in the so-called "oral" classrooms from which the deaf sample was drawn. As Mindel and Vernon (1971) point out, the oral method places such heavy emphasis on speech and speechreading (i.e., lipreading) that little attention is given to content, especially the laying down of a solid foundation of basic conceptual skills. As the same authors point out, these educational deficiencies are often compounded by deficiencies in the general life experience of the deaf child. These deficits may be due to an overprotective attitude on the part of the parents, to parental anxieties for speech at the expense of cognitive development, or simply to the lack of an effective channel of communication which denies the deaf child the vicarious or incidental learning which is a part of normal development. As a consequence of his familial and educational experiences, the deaf child often learns that it is more important to appear pleasant and attentive to the hearing adults in his environment than to actually learn or attend to the task at hand.

Furth (1963a, 1966) has suggested a similar explanation for the failure of the deaf on certain tasks. He suggested that although the deaf as a group are comparable to the hearing in their ability to learn in a specific situation, they lack a "discovery set" and hence are unable to transfer or generalize what they have learned in one situation to another similar but distinct situation. As applied to the current
study, this hypothesis might be conceptualized as follows. The Hearing Ss were aided in their performance by the incidental discovery of the rule, "The chip is always under the same figure," whereas for the Deaf Ss each new stimulus pair constituted a new situation in which previously obtaining structures would not be expected to hold. Furth has suggested that this deficit in transfer ability is due to deficits in general experience rather than to linguistic deficiency but the evidence which he cites to support his contention is not convincing (Furth and Youniss, 1965, Furth, 1966, Youniss and Furth, 1967). Oleron and Gumusyan (cited in Furth, 1970) have suggested a similar deficit but they propose that linguistic habits are responsible for the establishment of internal symbolic habits which intervene in the perceptual recognition of the environment.

Continuing the same line of reasoning but stating the case differently, one might say that successful performance on a visual discrimination learning task requires not only the perceptual recognition that the stimuli are different but also the cognitive recognition that the perceptual difference "makes a difference". Anecdotal data emerged from this study which suggest the possibility that such cognitive recognition is a well-established habit for hearing children but is relatively lacking in deaf children. At the outset of the testing for each S, the poker chips which were used as reinforcers were neatly stacked, separated by color, near E but in full view of S. (This arrangement was an artifact of the manner in which the chips were packaged and was maintained simply to insure uniformity of conditions.)
It might be argued that a random presentation of colors would have been more desirable but in fact no systematic effect of the colors emerged, i.e., the Ss did not attach any significance to the color of the chips, at least in regard to the experiment.) The Hearing Ss invariably restacked the chips and separated them by color. The Deaf Ss, on the other hand, never stacked the chips and, except in a few instances, did not separate the chips by color despite the fact that several of the Deaf Ss drew E's attention to the fact when a change of color occurred. While this is obviously circumstantial evidence and susceptible to a number of interpretations, it does not seem unreasonable to assume that this behavior indicates that for the hearing child there exists a generalized expectation that perceptually recognized differences will be meaningful but that this expectation is lacking for the deaf child. Whether such an expectation would arise from linguistic habits or from more general experiences is a question which cannot be answered with the available data.

If in fact the deaf child of primary school age lacks certain cognitive habits found in his hearing agemate, the implications for the education of the deaf are clear. A restructuring of priorities would be in order with a shift of emphasis to the attainment of cognitive competence, including fundamental concepts and efficient learning sets and problem solving approaches. Such a foundation is necessary not only for support of learning both in and out of the academic situation but also, if we accept Piaget's contention that linguistic competence arises from cognitive competence, for the deaf child's learning in and
utilization of those channels of communication which are available to him (e.g., reading and writing). This is particularly important in light of the general failure of the oral system to achieve even those limited goals which it has traditionally set for itself.

The hypothesis of a nonverbal coding system in the deaf, as outlined above, is not supported by the results of this study. It is possible, however, that in the present study the effects of such a system were obscured by one or more of the extraneous variables mentioned above. It would, therefore, be of interest to repeat this study with a younger sample where the hypothesized "learning sets" would not be so well established and the effects of verbal mediation might be more pronounced.
CHAPTER VI
SUMMARY

The evidence for a hypothetical nonverbal coding system in the deaf was examined. It was proposed that the effects of such a system should be evidenced in a comparison of the performance of deaf and hearing subjects on a task requiring verbal mediators or facilitated by verbal mediators. The task chosen was visual discrimination learning and the availability of verbal mediators was controlled by using common regular shapes on the one hand and random shapes of low association value on the other. It was predicted that when verbal labels were available the performance of deaf and hearing Ss would not differ but that deaf Ss would perform significantly better than hearing Ss when verbal labels were not available. For the deaf Ss, both situations would involve the same mediational system. For the hearing Ss, however, the former condition would involve the accustomed mediational system while the latter condition would either be nonproductive of mediators or require the use of a mediational system which the S was unaccustomed to using.

The prediction was tested on two groups, one deaf and one hearing, of 16 boys, drawn from the same geographical area. The samples were matched for age (range 5-8 to 8-7; $\bar{X}$=6-10) and also roughly matched for family socioeconomic status. The predicted differences did not emerge and in fact the Hearing Ss demonstrated a consistent superiority tending toward but not reaching statistical significance. Although ease of learning and availability of labels were related, it was suggested
that this finding was due to the operation of some underlying variable such as complexity of shape or familiarity. It was also noted that the performance of the Deaf Ss was heterogeneous, clustering at the extremes of performance rather than distributing itself over the available range.

Several possible explanations for the inferior performance of the deaf were discussed including the possibility of neurological involvement in a portion of the sample (relevant to the heterogeneity of performance noted), specific educational or experiential deficits, and failure to achieve appropriate set. The need for increased emphasis on the attainment of cognitive competence in deaf education was discussed.
BIBLIOGRAPHY


Vander Woude, Kenneth W. Problem solving and language: A comparison of the problem solving processes used by matched groups of hearing and deaf children. Chicago: Loyola University, Loyola University Psychometric Laboratory, undated (Publication No. 54).


APPENDIX A

REPRODUCTIONS OF STIMULUS FIGURES

HIGH CODABLE STIMULUS PAIRS

PAIR 1

PAIR 3
PAIR 5

LOW CODABLE STIMULUS FIGURES

PAIR 2
APPROVAL SHEET

The dissertation submitted by William J. White has been read and approved by members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

\[5-15-72\]

Date

[Signature of Advisor]