DOCUMENT RESUME

ED 112 572 EC 073 766

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TITLE The Effect of Orthographic Structure on the Perception of Letter Sequencies by Deaf and Hearing Children.
PUB DATE 75
NOTE 30p.; Paper presented at the Annual Meeting of the American Educational Research Association (Washington, D.C., March 30-April 3, 1975); Not available in hard copy due to light print of original document

EDRS PRICE MF-$0.76 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Aurally Handicapped; *Deaf; Elementary Secondary Education; Exceptional Child Research; Grade 1; Grade 2; Grade 4; Learning Characteristics; *Performance Factors; *Reading Skills; *Visual Stimuli; *Word Recognition

ABSTRACT

To investigate the development of the process whereby deaf Ss attend to the orthographic structure of written materials, the perception of words and letter sequences by 108 deaf and hearing Ss matched at three grade levels (grades 1, 2, and 4) of word reading was studied. Ss were shown three sets of structured/unstructured stimuli (such as "VUNS" and "NSUV") and were instructed to write down all or as much of the stimulus as they could after the cessation of the stimulus presentation. It was found that both the deaf and hearing Ss were influenced by orthographic structure at the earliest levels and that the hearing Ss showed no over-all superiority in this task. An additional finding that fourth grade level deaf Ss performed better than hearing Ss on unstructured items led to the conclusion that older deaf Ss had developed a compensatory skill permitting superior perception of unstructured items. (Author/LS)

1975 AERA Session # 10-09

ED112572

The Effect of Orthographic Structure on the Perception of Letter Sequences by Deaf and Hearing Children

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This study sought to investigate the development of the process whereby deaf Ss attend to the orthographic structure of written materials. Three stimulus sets (n/2 structured, n/2 unstructured) and three factorial designs were used to study the perception of words and letter sequences by 108 deaf and hearing Ss matched at three grade levels of word reading (1, 2, 4). It was found that both the deaf and hearing were influenced by orthographic structure at the earliest levels. Unlike earlier findings, the hearing enjoyed no over-all superiority in this task, a difference discussed in terms of matching procedures. In addition, the Ss x Materials interaction was significant at the 4th grade level with these older deaf performing as well on structured items and better on unstructured items than did the hearing.

EC073766

The Effect of Orthographic Structure on the Perception of Letter Sequences by Deaf and Hearing Children

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It is by now well established that the prelingual deaf, those who are or become deaf before the acquisition of language, fall far behind their age-matched hearing counterparts in educational achievement, especially reading (Myklebust, 1964; Furth, 1966). Having no useful experience with the acoustic aspects of language, the deaf must presumably decode written materials directly to meaning without the benefit of the mediation of acoustic cues which, according to at least two reading models (Smith, 1971; Gillooly, 1971), is so important to the word attack skills of the hearing. This study sought to determine whether the unavailability of a sound system and the mediational cues it affords affects the perception of letter sequences by the deaf and, if so, the age of onset of such an effect.

Gibson and her co-workers have clearly shown that the decoding strategies of the hearing reader, both the mature reader (Gibson, et al., 1962) and the beginning reader (Gibson, et al., 1963), are, to a great extent, influenced

[1]The authors express their appreciation to Mrs. Dorothy Battin, Principal, Lower School, Mr. Alan Summers, Principal, Middle School, Miss Elizabeth Titsworth, Director of Education, and teachers and staff of the Katzenbach School for the Deaf (West Trenton, New Jersey) for their cooperation in assisting the conduct of the study. The authors also wish to thank Mr. Anthony J. Caporaso, Principal of Public School 40R (Staten Island, New York) for his cooperation in the testing of the control group.

by the pronounceability of a given letter sequence. Pronounceability, according to the Gibson papers, consists in the invariant mapping of speech sounds to symbol sequences (phoneme-grapheme correspondence) and the high-order constraints dependent upon the position of letters within a sequence. On tachistoscopic presentation of such sequences generated according to these principles of pronounceability, it was found in both Gibson studies (1962; 1963) that hearing Ss perceived pronounceable items more easily and at shorter exposure times than they did unpronounceable items.

To determine whether pronounceability was, in fact, the key factor in facilitating perception, Gibson, et al. (1970) presented the same materials to college-age deaf mutes to whom the phenomenon of invariant symbol-to-sound mapping is unknown. Finding that the deaf Ss were aided as much by the pronounceability or lawfulness of sequences as were hearing Ss, Gibson concluded that the effect she had thought to be due to pronounceability is really the result of orthographic regularity, the rules governing the internal structure of words. Other workers with the deaf, using materials different from Gibson's (Doehring and Rosenstein, 1960; Hartung, 1970; Chen, 1973), have found, too, that deaf children are as influenced by pronounceability, or what Gibson has come to call orthographic structure, as are hearing children.

Although the deaf are influenced by orthographic structure as much as are the hearing, the 1970 Gibson study found there was over-all superiority in the performance of the hearing over the deaf on both structured and unstructured items. Is this lag in the perception of letter sequences a finding generally applicable to the deaf or is it rather the result of Gibson's matching procedures? Gibson, et al. (1970) were not specific about their matching variable, but they presumably matched on approximate age. Since the deaf's reading is known to lag when age is the matching variable, their findings are not surprising.

It is the purpose of this study to investigate the development of the perception of the deaf child, in particular, the development of the process whereby he attends to the orthographic structure of written materials. This investigation is based on Gibson's 1963 study but uses deaf and hearing Ss matched on three grade levels of reading, 1st, 2nd, and 4th. By matching on the basis of word reading skill rather than age or grade placement, at least one factor involved in the reading superiority of the hearing will be controlled. It is predicted that the deaf, even at the earliest stage of reading, are influenced by the rules of orthography.

METHOD

Design

There were three sets of stimuli employed in this study and three experimental designs depending on the stimulus set.

For set A, the design was a 2 X 3 X 3 completely-crossed factorial with two repeated measures. The experimental factors were: sex (M/F), reading grade level (grades 1, 2, 4) and subjects (oral deaf, non-oral deaf, and hearing). The repeated measures were: stimulus structure (orthographically regular/irregular), and length of stimulus (4 and 5 letters).

For stimulus set B, the design was a 2 X 2 X 3 completely-crossed factorial with one repeated measure. The experimental factors were: sex (M/F), reading level (grades 1, 2), and subjects (oral deaf, non-oral deaf, and hearing). The repeated measure was stimulus structure or meaningfulness (orthographically regular trigram, orthographically irregular trigram, three letter word).

For stimulus set C, the design was a 2 X 3 completely-crossed factorial with two repeated measures. The experimental factors were: sex (M/F) and subjects (oral deaf, non-oral deaf, and hearing). The repeated measures were: stimulus structure (orthographically regular/irregular) and length of stimulus (4, 5, and 6 letters).

All data were analyzed by an IBM 360-65 computer using the Statistical Analysis System (SAS) program for ANOVA with repeated measures, correcting for unequal cell numbers by regression analysis (Barr and Goodnight, 1972).

Subjects

Sixty-three deaf Ss, 9 to 14 years of age from the Katzenbach School for the Deaf (West Trenton, New Jersey), were given the Vocabulary Reading subsections of the appropriate form of the Gates-MacGinitie Reading Test (Primary A and B and Survey D all Forms 1). These Ss constituted the entire population at the Katzenbach School who fit the following criteria: normal intelligence (90-110), prelingual deafness, profound deafness (average hearing loss of 80 dbs. or greater), and no other neurological impairment.

Ss were classified as being oral (n = 32) or non-oral (n = 31) deaf based on their principal means of communication, the oral group by speech and the non-oral by sign and gesture as determined by their classroom teachers and supervisors. The child's intention to communicate orally, not the intelligibility of his/her speech, was the deciding factor in assigning the classification.

The problem of finding an appropriate hearing control group for research on the deaf is not easily resolved. The well-documented educational deficiencies of the deaf (Furth, 1966; Myklebust, 1964) rule out matching on the basis of chronological age or grade level. The different nature of the tests involved (verbal for the hearing and non-verbal for the deaf) rule out matching on the basis of mental age. Since a facet of work reading skill is the topic of inquiry here, it was decided to match hearing Ss with the oral and non-oral deaf on the basis of their performance on the Vocabulary

Reading subsection of the Gates-MacGinitie Reading Test (1973).

Accordingly, this test was administered to four grades of children at Public School 40R (Staten Island, N. Y.), and 45 normal hearing Ss whose scores most closely corresponded to those of the deaf Ss at 1st, 2nd, and 4th reading grade levels were selected for inclusion in the study. It was considered by the Es that the social class background of the Ss attending P.S. 40R corresponded closely to that of the population of the Katzenbach School.

Table I details the classification of Ss by hearing status, age, sex, and reading grade level. It may be noted that the mean age of the 1st

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Insert Table I here

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grade hearing Ss is greater than could be expected. Experience showed that the average 6-year-old cannot meet the response demands of the task (particularly the writing of the responses). Therefore, 2nd and 3rd grade children of normal intelligence who scored at the 1st grade level on the reading test formed the 1st grade control group. By including these older Ss as controls, the discrepancy in maturity which ordinarily favors the deaf Ss because of their educational deficits was reduced.

Materials

Three sets of structured/unstructured stimuli were used. Set A consisted of the 10 four and 10 five letter sequences (n/2 structured, n/2 unstructured) employed by Gibson et al. (1962).

Stimulus set B consisted of the 30 trigams (n/3 structured, n/3 unstructured, and n/3 words) employed by Gibson et al. (1963). Both the set A and

Table 1

Breakdown of Subjects by Age,

Reading Score, and Sex

		Mean Age	Mean Reading Score	# Males	# Females
First Grade Level	1. Hearing	7.70	1.60	6	6
	2. Oral Deaf	8.95	1.56	3	3
	3. Non-oral Deaf	9.07	1.51	3	3
Second Grade Level	1. Hearing	7.91	2.56	12	13
	2. Oral Deaf	9.88	2.43	8	8
	3. Non-oral Deaf	10.86	2.48	10	5
Fourth Grade Level	1. Hearing	9.33	4.51	11	7
	2. Oral Deaf	13.74	4.50	6	4
	3. Non-oral Deaf	14.66	4.26	7	3

B materials controlled for letter frequency and set B additionally controlled for trigram frequency as explained in the Gibson papers.

Stimulus set C consisted of 20 additional 4, 5, and 6 letter sequences used by Gibson, et al. (1962) (n/2 structured, n/2 unstructured) plus the 20 stimuli of Set A. The total set C consisted of 10 four, 16 five, and 14 six letter sequences (n/2 structured, n/2 unstructured).

Table 2 presents stimulus sets A, B, and C. Sets A & B were presented to all Ss on 1st and 2nd grade reading levels. Set C was presented to Ss

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Insert Table 2 here

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on a 4th grade reading level.

Each stimulus item (70 in all) was typed with a primary typewriter in upper case letters (1/4 inch on Crane's off-white bond paper, photographed with KODAK black and white slide film, and developed as a 2 X 2 mm. slide. An equal number of slides were prepared with each consisting of two black, parallel horizontal lines placed at the center of the slide. These slides served as a ready signal and fixation point as described in the procedures section. Finally, 70 blank slides (translucent white) were used at each inter-stimulus interval.

Apparatus

Two Kodak Ektagraphic Carousel projectors (Model #8) equipped with 4 inch Ektagraphic lenses, one loaded with slides of the stimulus items, the other with slides containing the parallel lines and the translucent slides, were controlled by three Hunter Decade Interval Timers. The stimulus items were projected on a screen through a Gerbrands tachistoscopic shutter, also controlled by the timers. The equipment was wired in such a way that once a stimulus interval was begun manually all other intervals were timed automatically.

Table 2

Lists of Stimulus Sets A, B, and C Arranged as

Structured and Unstructured Sets

Test A		Test B			Test C	
Pron.	Unpron.	Word	Pron.	Unpron.	Pron.	Unpron.
VUNS[7]*	NSUV[3]	CAT[1]	TAC[29]	TCA[10]	VUNS[39]	NSUV[10]
LODS[2]	DSOL[10]	CAN[3]	NAC[16]	NCA[20]	GLOX[3]	XOGL[16]
DINK[13]	NKID[5]	PUT[4]	TUP[22]	PTU[21]	LODS[5]	DSOL[37]
SULB[14]	LBUS[8]	AND[5]	NAD[28]	DNA[6]	DINK[8]	NKID[7]
GLOX[19]	XOGL[16]	PIG[11]	GIP[20]	GPI[8]	SULB[27]	LBUS[25]
GRISP[18]	SPIGR[4]	PET[14]	TEP[17]	PTE[7]	BRELP[1]	LPEBR[36]
FRAMB[11]	MBAFR[17]	RAN[15]	NAR[13]	RNA[19]	TILMS[11]	LMSIT[35]
CLATS[9]	TSACL[20]	MAN[17]	NAM[18]	NMA[24]	BESKS[13]	SKSEB[21]
BRELP[6]	LPEBR[15]	GUN[23]	NUG[2]	NGU[12]	FUNTS[14]	NTSUF[33]
BESKS[1]	SKSEB[16]	SUN[26]	NUS[9]	NSU[25]	GRISP[30]	SPIGR[22]
					CLATS[31]	TSACL[21]
					FRAMB[32]	MBAFR[12]
					SLAND[40]	NDASL[24]
					BLASPS[4]	SPSABL[19]
					PREENT[9]	NTEEPR[15]
					SMAWMP[17]	MPAWSM[23]
					SPRILK[18]	LKISPR[20]
					KLERFT[28]	FTERKL[2]
					DRIGHK[29]	KIGHDR[34]
					BLORDS[38]	DSORBL[6]

*Digits following each letter sequence represent the place of that letter sequence in the random order of presentation.

Procedure

Each stimulus interval was 15 seconds long during which the black parallel, horizontal lines were presented. Two seconds after onset of the lines the stimulus was presented between them for a 400 msec. duration. The lines, therefore, served both as ready signal and fixation point. Only the lines remained on the screen for the additional 12.6 seconds of the 15 second stimulus interval. At the termination of the stimulus interval, one projector advanced to a blank slide thereby maintaining nearly constant illumination of the screen while the other projector advanced to the next stimulus item in preparation for the next tachistoscopic presentation. All stimuli were presented in random order.

The deaf Ss were familiarized with the laboratory setting and equipment several days prior to the actual experiment and instructed carefully by their principal on the demand characteristics of the experiment.

Ss were provided with one practice sheet consisting of 6 numbered lines and an answer booklet, each sheet consisting of 10 number lines. They were instructed to view the two parallel, horizontal lines as a ready signal, attend closely to the stimulus projected between the lines, and write down all or as much of the stimulus as they could, avoiding wild guessing. There were 6 practice stimuli consisting of words, structured, and unstructured letter sequences equal in length but not the same as the experimental stimuli.

Ss were encouraged to write their response as soon as possible after the cessation of the stimulus presentation, and E waited until each S had completed his response before initiating the next stimulus interval.

Deaf Ss were tested in pairs and all hearing Ss three at a time at individual desks 3-1/2 feet from the screen in a small, darkened room.

Results

Table 3 presents the mean number of completely correct responses for

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Insert Table 3 here

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stimulus sets A, B, and C. It can be noted that scores on Set A (4 and 5 letter sequences) for all Ss on the 1st and 2nd grade levels are extremely low, a range of mean scores from .3 to 1.9 correct per 10 stimulus items, while mean scores on Set B (3-letter words and structured and unstructured trigrams) for the same Ss are considerably higher, a range of 6.3 to 8.5 per 10 words, 4.5 to 8.4 per 10 structured trigrams, and 3.1 to 8.1 per 10 unstructured trigrams. This differential is due, no doubt, to the greater difficulty experienced by all Ss in processing 4 and 5 letter sequences. It can also be noted that mean scores for 4th grade Ss on Set C were no higher and, for some S groups, slightly lower, than for these same 4th grade Ss on Set A even though on Set C the scores represent mean number correct out of 40 and on Set A, mean number correct out of 20. This finding can be explained by the fact that the mean scores for Test C are brought down considerably by extremely poor responses to 6-letter sequences, a mean of 1 or below out of 7 for unstructured items and 2 or below out of 7 for structured items.

Stimulus Set A

Analysis of variance of the 2 X 3 X 3 factorial design by means of regression analysis exceeded the capabilities of the existing SAS program for ANOVA. However, numerous incomplete solutions indicated that reading level was a highly significant main effect, a finding which suggested that

Table 3

Mean Number of Completely Correct Responses to Stimulus Items by Oral Deaf, Non-Oral Deaf and Hearing Ss to Stimulus Sets A, B, and C

Stimulus Set A (mean # correct out of 10 stimuli)

	Hearing		Oral Deaf		Non-Oral Deaf	
Grade	U*	S*	U	S	U	S
1st	.7	1.6	.3	.8	.5	.7
2nd	1.1	1.9	1.0	1.9	1.1	1.9
4th	1.5	3.7	2.7	3.9	2.3	3.6

Experiment I, Test B (mean # correct out of 10 stimuli)

Grade	U	S	WORD	U	S	WORD	U	S	WORD
1st	5.6	6.4	8.1	4.4	5.0	6.3	3.1	4.5	7.7
2nd	6.8	8.3	9.4	7.0	8.4	9.4	8.1	8.3	9.5

Experiment I, Test C (mean # correct out of 20 stimuli)

Grade	U	S	U	S	U	S
4th	1.2	3.5	2.5	4.1	2.7	3.8

*U = unstructured

*S = structured

three separate analyses, one for each reading grade level, would be worth while. Thus, the analysis for Set A was divided into three 2 X 3 factorial designs, each with two repeated measures. The three corresponding ANOVA Tables are presented here as Table 4.

Insert Table 4 here

It can be noted that both repeated measures, stimulus structure (P) and stimulus length (L), were consistently significant main effects at all grade levels. There was no significant main effect for the subject variable, Hearing, indicating no significant differences in the over-all performance of the three groups studied. Although, as can be noted by examination of the three parts of Table 4, several 2-way and 3-way interactions were significant, only the Ss x Materials interactions are of importance and will be considered in detail. At reading grade level 4, there was a significant 2-way interaction, Hearing by Stimulus Structure (H x P). Fig. 1 demonstrates

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Insert Fig. 1 here

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the differential response to unstructured and structured items as being greater for hearing controls than for either group of deaf Ss. It is clear that the 2 groups of deaf Ss did as well as the hearing on the structured materials and actually better than the hearing on the unstructured materials.

Stimulus Set B

The ANOVA Table for Set B (see Table 5) indicates significant main

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Insert Table 5 here

Table 4

ANOVA Tables for Set A

Set A, 1st Reading Grade Level

Source	DF	Sums of Sq.	Mean Sq.	F
Hearing (H)	2	5.8	2.9	1.1
Sex (S)	1	.1	.1	.04
H x S	2	.71	.35	.1
ID (Hearing Sex)	32	83.37	2.6	
Length (L)	1	68.00	68.0	75.7 *
Pronounceability (P)	1	6.2	6.2	6.9 *
H x L	2	5.6	2.8	3.13*
S x L	1	0.0	0.0	.95
H x S x L	2	.24	.12	.86
H x P	2	.29	.14	.16
S x P	1	.21	.21	.23
H x S x P	2	.65	.33	.36
L x P	1	4.67	4.67	5.20*
H x L x P	2	.57	.28	.31
S x L x T	1	.17	.17	.18

Table 4 (Cont'd.)

Set A, 2nd Grade Reading Level

Source	DF	Sums of Sq.	Mean Sq.	F
Hearing (H)	2	.03	.02	.005
Sex (S)	1	9.07	9.07	2.4
H x S	2	9.57	4.78	1.3
ID (H x S)	49	180.83	3.74	
Length (L)	1	232.16	232.16	240.57 *
H x L	2	7.5	3.7	3.88 *
S x L	1	.05	.05	.05
H x S x L	2	.39	.19	.20
Pronounceability (P)	1	40.16	40.16	41.61 *
H x P	2	.08	.04	.05
S x P	1	3.16	3.16	3.28
H x S x P	2	1.64	.82	.85
L x P	1	4.09	4.09	4.24 *
H x L x P	2	.31	.16	.16
S x L x P	1	.13	.13	.14

Table 4 ('ont'd.)

Set A, 4th Grade Reading Level

Source	DF	Sums of Sq.	Mean Sq.	F
Hearing (H)	2	10.20	5.10	1.43
Sex (S)	1	2.34	2.34	.66
H x S	2	11.28	5.64	1.60
ID (H S)	18	64.16	3.56	
Length (L)	1	75.26	75.26	21.2 *
H x L	2	.78	.39	.50
S x L	1	.09	.09	.12
H x S x L	2	6.11	3.55	3.93 *
Pronounceability (P)	1	61.76	61.76	79.29 *
H x P	2	7.78	3.89	4.99 *
S x P	1	5.51	5.51	7.07 *
H x S x P	2	.19	.09	.13
L x P	1	11.34	11.34	14.56 *
H x L x P	2	.28	.14	.83
S x L x P	1	.01	.01	.90

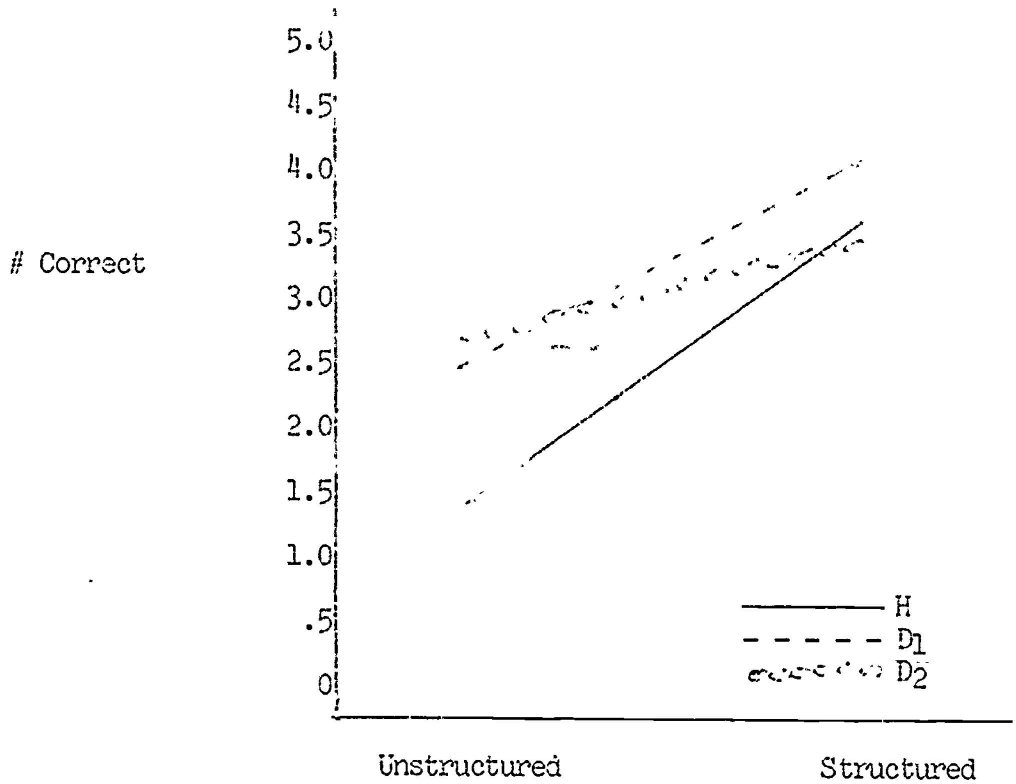

Fig. 1. For Test A, significant interaction between hearing and pronounceability (H x P) for Ss on a 4th grade reading level.

Tabl 5

ANOVA Table for Set B

Source	DF	Sums of Sq.	Mean Sq.	F
Hearing (H)	2	9.56	4.78	.34
Grade (G)	1	412.73	412.73	29.60 *
H x G	2	58.91	29.45	2.12
Sex (s)	1	20.09	20.09	1.45
H x S	2	19.93	9.96	.71
G x S	1	44.41	44.41	3.19
H x G x S	2	1.46	.73	.05
ID (H G S)	83	1151.88	13.9	
Pronounceability (P)	2	302.77	151.38	80.86 *
H x P	4	5.85	2.92	.78
G x P	2	9.26	4.63	2.47
S x P	2	.88	.44	.24
H x G x P	4	26.19	6.59	3.49 *
G x S x P	2	.09	.05	.02
H x S x P	4	10.23	2.54	1.36
H x G x S x P	4	1.64	.41	.22

effects for reading level (G) and for the repeated measure of stimulus structure (P). There was no significant main effect for the subject variable, Hearing, nor was there any significant Ss x Materials interaction.

Stimulus Set C

The ANOVA Table for Set C (see Table 6) indicates a greater refinement

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Insert Table 6 here

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of the error term, a procedure which, though possible here, proved too complex for the SAS ANOVA program in analyses of Sets A and B. Again, the two repeated measures, stimulus structure (P) and stimulus length (L), were significant main effects. The Ss x Materials interaction H x P, presented in Fig. 2, was significant as it was for Set A for Ss on a 4th grade level

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Insert Fig. 2 here

(see Fig. 2). Both groups of deaf were seen to be less affected by the absence of the factor of stimulus structure than were the hearing controls, performing as well on structured materials and better on unstructured materials than did the hearing controls.

The Repeated Measures. The interaction between the two repeated measures, stimulus structure (P) and stimulus length (L), significant on analyses of Sets A and C, demands some further explanation. Fig. 3 shows Ss on a 4th

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Insert Fig. 3 here

Table 6

Analysis of Variance Table for Stimulus Set C

Source	df	Sums of Sq.	Mean Sq.	F
Hearing (H)	2	30.27	15.13	1.9
Sex (S)	1	8.03	8.03	1.01
H x S	2	26.08	14.04	1.7
Stimulus Length (L)	2	268.51	134.25	100.09 *
H x L	4	3.63	.90	.67
S x L	2	1.35	.67	.51
H x S x L	4	14.13	3.7	2.8 *
Pronounceability (P)	1	121.0	121.0	101.0 *
H x P	2	10.38	5.19	4.4 *
S x P	1	1.00	1.00	.83
H x S x P	2	2.44	1.22	.86
L x P	2	52.79	26.39	25.1 *
H x L x P	4	8.40	2.1	2.0
S x L x P	2	3.29	1.64	1.5
ID (H S)	18	142.27	7.90	
ID x L (H S)	36	48.36	1.34	
ID x P (H S)	18	21.16	1.19	
ID x L x P (H S)	36	36.16	1.05	

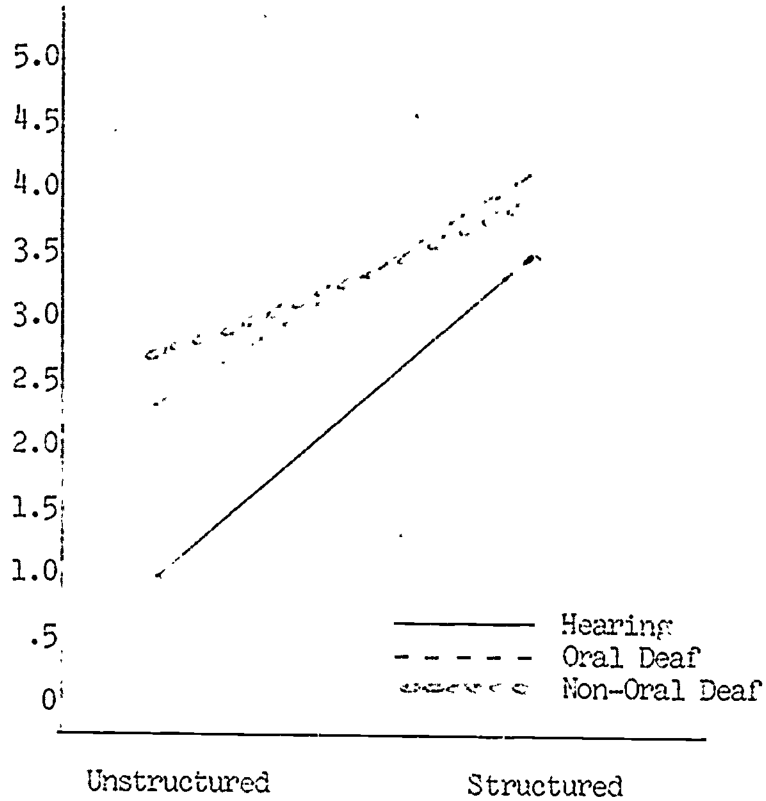

Fig. 2. For Test C, a significant interaction between hearing and pronounceability (H x P) for Ss on a 4th grade reading level.

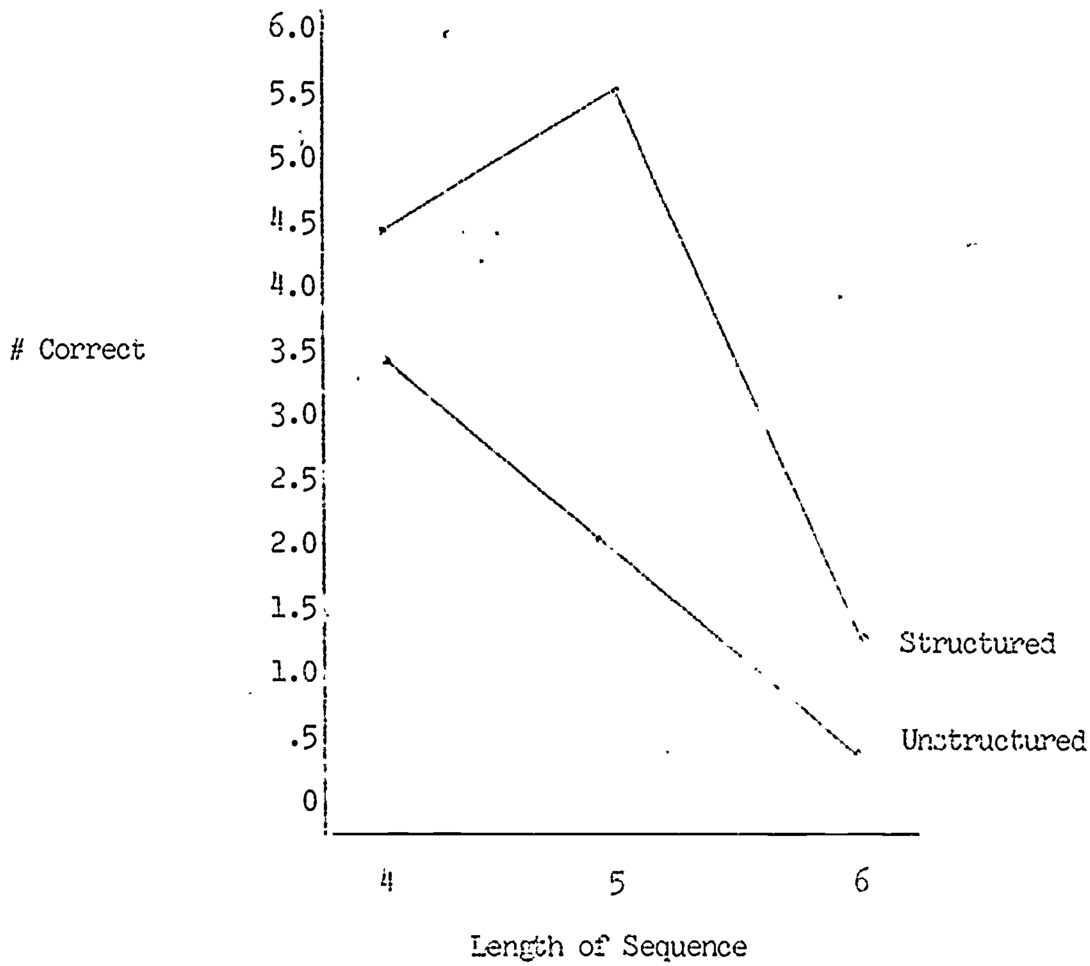

Fig. 3. For Test C, a significant interaction between the 2 repeated measures, pronounceability and length of sequence (P x L), for Ss on a 4th grade reading level.

grade reading level (Set C) responding more differentially to the factors of stimulus structure on 5-letter sequences than on either 4-letter or 6-letter sequences. Fig. 4 shows Ss on the 1st and 2nd reading levels

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Insert Fig. 4 here

(Set A) responding to the factor of stimulus structure more differentially on 4-letter than on 5-letter sequences. These data suggest the possibility that for Ss reading on 4th grade level the 5-letter sequence is the most appropriate test of response to stimulus structure and that for Ss reading on a 1st and 2nd grade level, the 4-letter sequence is most appropriate.

Error Analysis. Errors in response to Stimulus Sets A and B were noted and analyzed only in cases where a written response appeared more or less structured than the stimulus. The judgments were subjective, based on the Es' own perception of orthographic structure. The criteria for noting an error were as follows: when an unstructured item was written as more structured, a structured item written as less structured, or a structured or unstructured item transformed into a word.

Of errors which altered stimulus structure the overwhelming percentage at all grade levels for all groups of Ss were in the direction of greater structure being built into the response. Table 7 shows these percentages.

Insert Table 7 here

In a Sign Test in which errors from U to S were compared with errors from S to U, $X^2 = 8.5$, df = 1, significant at the .01 level.

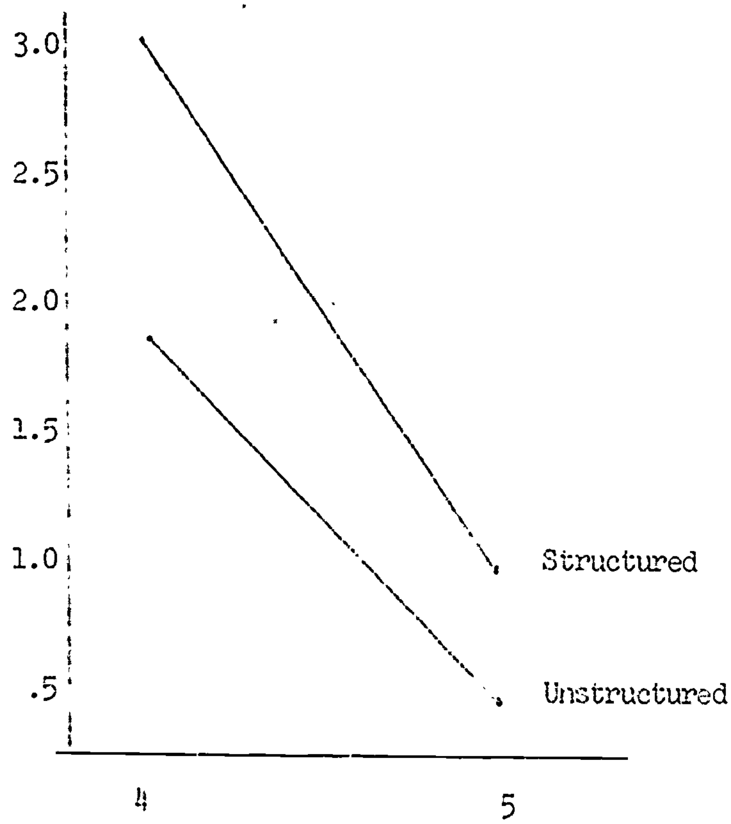

Fig. 4. For Test A, a significant interaction between 2 repeated measures, pronounceability and length of sequence, for Ss on 1st and 2nd grade reading levels.

Table 7

Percentages of Errors which Altered the Orthographic

Structure of the Stimuli

Experiment I

Set A	Hearing		Oral Deaf		Non-Oral Deaf	
Grade	U-S	S-U	U-S	S-U	U-S	S-U
1st	83	17	72	28	83	17
2nd	91	9	79	21	81	19
4th	94	6	94	6	88	12
Set B						
1st	88	12	71	29	83	17
2nd	93	7	91	9	65	36

Discussion

The major experimental finding, indicating clearly no significant difference between the deaf and hearing in the perception of structured items, demonstrates that deaf children at three grade levels of reading are influenced as much by orthographic structure as are hearing children in their perception of letter sequences. This finding conforms to the results of other studies with the deaf (Doehring and Rosenstein, 1960; Hartung, 1970; Gibson, et al., 1970; Chen, 1973). Because the acoustic aspects of language are irrelevant to the deaf, this finding lends support to Gibson's conclusion (1963; 1970) that it is orthographic structure, not pronounceability per se, to which all Ss, hearing and deaf, attend. The influence of orthographic structure begins at the earliest stages of learning to read (1st and 2nd grade levels) and continues throughout a more advanced stage (4th grade level).

Unlike Gibson's 1970 findings, there was no over-all superiority enjoyed by hearing Ss in this study. It is concluded that this outcome is due to the fact that matching was in terms of a measure of reading performance, not age.

The finding of a significant Ss x Materials interaction only for Ss reading on a 4th grade level (mean age 14.2) offers further insight into the development of the perceptual capacities of the maturing deaf child. As can be noted in the analysis of the data from Set A when each grade was analyzed separately (see Fig. 2) and in the analysis of data from Set C (see Fig. 5), the deaf Ss responded as well to structured items but better to unstructured items than did their hearing counterparts. These deaf children seem to have learned the rules of orthography as well as the hearing children with whom they were matched and, in addition, seem to have developed a compensatory skill which permits superior perception of unstructured items. It is possible that only after the deaf child reaches adolescence can this additional skill, what we might call "visual reading," become well developed. Apparently, this compensatory skill which is clearly not based on the perception of orthographic structure does not emerge until the deaf child enters a more advanced stage of reading.

Evidence for such a compensatory skill was not found by Gibson, et al. (1970) in their use of similar materials with college-age deaf; that is, they found no Ss x Materials interaction. The reason for such a disparity in findings is unknown.

It might be argued that the results obtained with the older deaf Ss in this study (that is, their superior perception of unstructured items) is simply an artifact of the matching procedure. For example, matching on the basis of word reading skill did result in a disparity in age between deaf and hearing Ss at all grade levels (see Table 1). Countering such an argument, however, is the fact that, though hearing and deaf were matched in the same way at three grade levels of reading, the significant Ss x Materials intereaction emerged only for those Ss reading on a fourth grade level. If the matching procedure itself produced the significant interaction, one could expect the same results to appear at all grade levels (via a main effect).

It might also be argued that the experimental outcome, that is the change in results across grade levels, may reflect a change in the reading curriculum at the Katzenbach School. However, according to the supervisors at the school, there has been the same strong emphasis on the teaching of phonics and phoneme-grapheme correspondence for over ten years, a reading program to which all Ss in our study are and have been exposed.

Finally, the results of this study trace the developing perceptual capacities of the deaf as he learns to read. Clearly, the prelingual deaf child at the 1st, 2nd, and 4th grade levels of reading is as capable as is his hearing counterpart in attending to orthographic structure. That he comes to this perception of orthographic structure without benefit of acoustic mediation suggests that the decoding aspects of reading by the deaf involve a visual-cognitive process from the earliest stages of learning to read. In addition, as the results of this study indicate, a further perceptual capacity becomes available to the deaf adolescent, a capacity based on a refined means of "visual reading" not wholly reliant on orthographic structure.

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