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ABSTRACT

The effectiveness of the Ling System of Speech Training (which uses a systems analysis and task analysis approach to determine speech tasks by level, their prerequisites, and subskills) in facilitating gains in the suprasegmental and segmental aspects of speech and in speech intelligibility was examined with 15 hearing impaired children (5-8 years old). Analyses on pre- and post-treatment speech samples were completed via phonetic transcriptions. Ss received individual speech therapy from speech pathologists trained in the Ling method. Treatment included an individualized program based on speech production skills in the most appropriate modalities. Results revealed that the Ling system was effective with the majority of children, resulting in significant gains in the production of suprasegmental and segmental aspects of speech and in speech intelligibility. Additional findings showed that poor phonatory control and lack of control over duration were the salient characteristics of children who exhibited the least gains in speech intelligiblity, in general, and across all speech features, in particular. (CL)

FINAL PERFORMANCE REPORT

G00-7902270

An Evaluation of a Systematic Approach to Speech Instruction for Young Hearing Impaired Children

Judith Mandell

AN EVALUATION OF A SYSTEMATIC INDIVIDUALIZED APPROACH TO SPEECH INSTRUCTION FOR YOUNG HEARING IMPAIRED CHILDREN

JUDITH MANDELL

Statement of the Problem

Effective oral communication skills are critical to the hearing impaired person who seeks to compete in a hearing world and to achieve a role commensurate with his/her abilities. As speech is the vehicle for linguistic expression, it must be intelligibile to the listener and is therefore an important factor in the communication process.

Assessment of speech intelligibility in studies undertaken during the past 35 years reveals that "similarly poor levels of speech achievement among hearing impaired children are commonplace in our special schools and have been so for many years" (Ling, 1976). Levitt (1976) in summarizing his investigation of the speech intelligibility of hearing impaired subjects in a longitudinal study, reported that there was a "relatively large proportion of children with low ratings. Nearly one in three children received the lowest possible rating of unintelligibile speech and there was little evidence of any improvement over the years." Ling, in advocating high standards of speech production, noted that research findings even in the 1970's indicate that speech instruction is neither methodical nor consistently developed during the child's years in school.

Vorce (1961) in her study of the state of speech curricula reported that:

> The area of planning speech curriculum for deaf children is among the most difficult, for, unlike other general areas of study. . . there has been little or no experimentation in speech content or methodology, and few models exist from which a curriculum might be adapted.

Concern had been registered by both oral and total communication programs regarding the lack of an effective speech curriculum, (Vorce, 1961; Ling, 1976; Osberger and Levitt, 1977; Alexander, 1978). There was a need to research a systemized approach to speech instruction for hearing impaired children based on current research findings relating to speech intelligibility studies, sensory input systems, and innovative instructional strategies.

Of the various published approaches used in speech instruction currently, the Ling Model (1976) presented a theoretical base supported by research studies on speech acquisition. He employed a systems analysis and task analysis approach in the determination of speech tasks by level, their prerequisites and sub-skills. He stressed the importance of individual assessment, individual needs, and a sequential approach.

However, as with many new systems, although founded on a firm research base, careful, controlled, published findings of its actual effects and/or benefits had not, thus far, been provided. There was a need, therefore, to provide teachers of the hearing impaired and speech pathologists with this information so that they could begin teaching speech to the hearing impaired with confidence.

The purpose of this study was to evaluate the effectiveness of the Ling System of Speech Training as an appropriate method for facilitating gains in the suprasegmental and segmental aspects of speech and in speech intelligibility

Objectives and Questions

The primary objectives of the study were:

1. To undertake a program of individualized speech instruction employing the Ling System of Speech Training with very young hearing impaired children.

2. To report the effectiveness of such individualized speech instruction in terms of changes in certain specific suprasegmental and segmental features of speech.

Secondary objectives were:

1. To develop a procedure for collecting speech samples of very young hearing impaired children.

2. To develop measure(s) for analyzing both suprasegmental and segmental aspects of speech in very young hearing impaired children.

The following questions were asked:

1. To what extent does the Ling System of Speech Training foster gains in suprasegmental aspects of speech?

   a. Phonatory Control
   b. Durational Control
   c. Stress
   d. Continuity of Utterance

2. To what extent does the Ling System of Speech Training foster gains in segmental aspects of speech?

   a. Vowels and Diphthongs
   b. Consonants

3. Does intelligibillity increase as a result of these gains?

4. What specific aspects of speech are correlated with intelligibility?

Subjects-Materials-Procedures

Subjects

Fifteen hearing impaired children enrolled in a Pennsylvania County School System constituted the population. The subjects met the following criteria:

a. Chronological Age: 5.6 - 8.0 years.
b. Site of Lesion: sensorineural with no evidence of Central Nervous System disorder as determined from health and medical records.
c. Hearing Loss: Risberg and Martony, B2 through D6 audiometric class (Appendix A).
d. I.Q.: normal or above as determined from school records.
e. Other Handicaps: no diagnosed secondary handicaps of educational significance.

Procedures Used in Pre- and Post-Test Speech Assessment

Pre and post-treatment tape recordings of speech samples were collected as follows:

Situation I. Play with Toys: From a large box on the table, the speech tutor took out the toy materials in the following order: Mother, Father, Boy, Girl, Baby, Boat. Each toy was given to the child by the tutor who encouraged him/her to "Tell me about this". The tutor's verbalizations to the child were limited to such comments as, "Tell me more"; "Oh, that's nice"; "Umm"; "What happened?". Direct questions which would result in only one possible single word response were not permitted as the investigator was interested in more spontaneous utterances.

Situation II. Sequence Pictures: The speech tutor placed a book of five sequence pictures in front of the child and asked him/her to "Tell me a story". The pages were turned one at a time by the tutor when she felt that the child was finished. The tutor's comments were limited to those described above.

Situation III. Elicited Responses to Pictures: The speech tutor asked each child to respond to the pictures from the Goldman-Fristoe Test of Articulation by identifying the color of the picture or by identifying the action of the picture. The tutor said, "What is this?" and initially helped the child in coding the response, i.e. "A red house". Once the child learned the response pattern Art + Adj + N, the testing began. The tutor turned the pages one at a time, indicating that the child was to respond with the pattern, Art + Adj + N. Following this segment, she showed the child a series of verb pictures and preposition pictures. Again, she helped the child understand the response required, N + be + Ving or N + be + prep + N. Once the child learned the response patterns, the tutor turned the pages with no additional comments.

Equipment

The investigator audiotaped all sessions using a Nagra IV half track monaural tape recorder and Sony ECM Electret microphone. Scotch brand high output/ low noise propack audiotape was used throughout the taping and analyzing sessions. These tapes were electronically edited using an Ampex AG 440 and a Revox A77 Tape Recorder at 7½ RPS.

Two master tapes were made which included pre and post treatment utterances of each subject. Tape I included pre and post treatment utterances from Situation I and II; Tape II included pre and post treatment utterances from Situation III. On each tape, the order of children and the order of presentation of pre and post treatment speech samples were randomized. (Arkin and Colton, 1950).

Phonetic Transcription

Two Speech Pathologists (CCC) with experience in phonetic transcription transcribed all utterances from Audiotape I and II (See Appendix B and B-1). The investigator examined the phonetic transcriptions for the 15 subjects, evaluating each phoneme in order to determine:

a. Was there an error?
b. If so, what was the error type?
c. If so, what was the error category?

See Appendix B2 and B3.

Phonetic Level Evaluation

Each subject was given the Ling Phonetic Level Evaluation by his or her speech tutor. This assessment was administered to determine the extent to which suprasegmental and segmental patterns were present in each child's phonetic repertoire, the extent to which the child could differentiate one motor speech pattern from another, and the rate at which sounds could be repeated and alternated using different pitch, intensity, and stress patterns.

Target Selection

A comparison of sound patterns and suprasegmental features absent in either the spontaneous speech sample or the phonetic level sample was made. Specific speech targets were then chosen for individual therapy based on the above assessments.

Four phonetic level and two phonological level targets were initially selected for practice. As one target was achieved, another target was added. In some cases, the phonological level target was initiated after the phonetic level subskill had been acquired. Progress was reported by the following symbols: [-] error, [✓-] inconsistent error (subject able to produce the speech feature correctly some of the time), [✓] corrected.

Treatment Procedures

1. The speech pathologists (CCC) and teacher aide working with the children viewed videotapes of the Ling System of Speech Training. They engaged in five practice sessions of two hours each, over a two week period. They each administered the Ling Drills to two children not included in the present study. These sessions were videotaped and played back for critiquing by the investigator, speech pathologist and teacher aide to establish similar teaching types. In addition, the investigator observed the actual tutoring sessions for a two week period. Any variance in teaching styles among the tutors was immediately observed and discussed and appropriate changes were initiated.

2. The fifteen subjects received individual speech therapy from the trained speech pathologist for 15 weeks., Scheduling was for half hour sessions twice weekly or 30 half hour sessions in total. Due to school absence and vacation schedules, each subject was seen approximately 1.7 times a week with a mean total of 16 half hour sessions and a range of 14-22 total sessions. The aide trained in administering Ling Drills was scheduled to see each child four times a week for ten minute sessions or 60 total sessions. She saw each child approximately 3.4 times a week with a mean total of 52 sessions per child. The range of sessions was from 48-56 total sessions.

3. Each child began an individualized speech program based on his speech production skills. The hierarchy of targets and subskills provided by Ling in his Teacher/Clinician Planbook and Guide to the Development of Speech Skills (1978) were used in the treatment process. Strategies and types of general activities or games used often differed for each child based on his/her specific needs. These procedures were carefully recorded.

4. Ling's task analysis system was employed to determine the sensory modes most conducive to enable the child to discriminate and then produce the target pattern. In all cases the auditory modality was tried initially followed by the visual and tactile modes. When a target was established by either the visual or tactile modes, it was reinforced through the auditory modality in the event that the child would be able to evoke the target through auditory imitation.

5. Each subject had a flow chart which listed his/her weekly targets and subskills. Each individual administering speech instruction signed the chart and stated what was accomplished during the lesson. (See Appendix H.)

6. A weekly staff meeting was held with personnel working with each child to examine the speech targets and to plan the next week's targets.

7. At the end of the four month treatment period, each child was post tested using the same procedures described in the previous section.

Procedures for Analysis of Data

Suprasegmental Features

Three Judges, volunteers from the Masters Program in Education of the Deaf and Hearing Impaired at Teachers College, Columbia University, listened to Audiotape I, the more spontaneous speech sample. (See Appendix I, Instructions to Listeners.) They rated each subject's speech intelligibility on a scale ranging from one to five; a rating of one designated speech which could not be understood; a rating of two, three and four designated progressive gradations between unintelligible and intelligible speech.

The tapes were then replayed so that ratings could be made of the 12 prosodic features and of voice quality on a five category speech features rating scale where one equaled a poor level of performance and five equaled normal or appropriate performance (See Appendix J). A total speech features score was derived for each child based on an average of the 12 prosodic features: This scale was found to have high interval consistency and reliability. In addition, interjudge reliability was high ($P < .05$).

Segmental Features

The phonetic transcription of audiotape II was used for segmental analysis. The tape consisted of 30 recorded sample of 36 phrases each. A numerical code sheet was used for recording phoneme errors. (See Appendix M - Sample Recording Form).

The resulting data sheets were punched onto cards for computer analysis of frequency counts, gain scores pre and post treatment, phoneme errors according to feature, correlation and intercorrelation with intelligibility, suprasegmental errors and hearing loss.

Results

The data obtained in this study indicated that the Ling System of Speech Training was effective with the majority of children. There was significant improvement in all measured suprasegmental features. As indicated by the Total Speech Features Score, the average gain of the various suprasegmental targets was significant at the .01 level ($t=2.98$).

With respect to the segmental aspect of speech, pre to post test reduction in vowel and diphthong production was significant beyond the .01 level ($t=3.08$ and 3.15 respectively), and reduction in consonant errors was significant beyond the .001 level ($t=9.09$). Further, intelligibility improved pre to post test, significant beyond the .001 level ($t=3.90$).

Inspection of performance of subjects arranged in three groups by degree of hearing loss revealed differences, non-significant statistically, but with a trend towards a moderate positive relationship between hearing loss and performance on measures of prosody, phoneme production, and speech intelligibility.

As a group, Group I (Risberg-Martony HL B2) demonstrated greater gains in all aspects of speech and in intelligibility than Group II (Risberg-Martony HL B3 and C3). Group II demonstrated greater mean gains than Group III (Risberg-Martony HL C6, D5 and D6).

Those subjects who exhibited little gain in one aspect of speech demonstrated consistently little gain across all aspects of speech and speech intelligibility. The predominant characteristic of these subjects was their poor phonatory control and lack of control over duration.

In fact, with this population, the durational aspects of speech and phonatory control were most highly correlated with intelligibility ($\underline{r}$=.87 and $\underline{r}$=.78 respectively; $p < .001$). Further, the suprasegmental aspects of speech, in general, were more highly correlated with speech intelligibility than the segmental aspect (Total Speech Features Score, $\underline{r}$=.85, p .001; Consonant production, $\underline{r}$=.60 initial position, $\underline{r}$=.66 medial position, $\underline{r}$=.61 final position, $p < .01$; Diphthong production, $\underline{r}$=.45, $p < .05$; Vowel production, $\underline{r}$=.37, $p < .05$; Appendix Q).

With respect to frequency of phoneme errors, error type and error categories, the present findings were similar to those of earlier investigators.

The low central vowels were most often produced correctly, followed by midfront, midback, central, high front and high back vowels. Lax vowels were produced correctly more often than tense vowels. Errors of duration, primarily prolongations, followed by errors of place, primarily distortions and neutralizations were the most frequent errors. The consonants which were most often produced incorrectly were the palatal and alveolar fricatives. Errors of manner, errors of omission and errors of place and manner, in that order, were found to be the most frequently occurring errors. There was an increase in inconsistent phoneme error production pre to post test, indicative of a stage of learning correct production.

Conclusions

1. The use of the Ling System of Speech Training resulted in significant gains in the production of suprasegmental and segmental aspects of speech and in speech intelligibility over the four month treatment period with 15 hearing impaired pupils ranging in age from 5.0 to 8.0 years.

2. There was a moderate relationship both pre and post test between each of the suprasegmental and segmental features and hearing loss. In general, the greater the degree of hearing loss, the poorer was subject performance and subject gain. However, when the subjects were arranged in three groups according to degree of hearing loss, no significant difference among groups was observed.

3. With this population, the suprasegmental aspects of speech were most highly correlated with speech intelligibility followed by consonant production and then by diphthong and vowel production.

4. Of the suprasegmental features, phonatory control and the durational aspects of speech had the strongest positive relationship with speech intelligibility.

5. The relationship between hearing loss and intelligibility was positive but not statistically significant and for this group of children was not as highly correlated with speech intelligibility as the prosodic variables or consonant production.

6. The salient characteristic of those subjects who exhibited the least gains in speech intelligibility, in general, and across all speech features in particular, was their poor phonatory control and lack of control over duration.

7. For those children who experienced this severe difficulty in control of respiration and phonation, more time should have been spent on those speech targets prior to articulatory skill training which depends on this firm foundation.

8. In the present study, the frequency of occurrence of specific phoneme errors and correction of these errors is similar to data on phoneme acquisition in previous studies substantiating earlier findings on vowel and consonant development and stages of learning.

Recommendations and Implications for Future Research

1. It is recommended that the following comparative studies be undertaken to provide more information regarding the significance of gains fostered by the use of the Ling System.

   a. A study involving two groups of children of similar ages, with one group receiving the Ling System of Speech Training, and the other group using a different approach.

   b. A study involving hearing impaired subjects at varying ages, from preschool through adulthood. Variations may exist at different age levels regarding rate of progress and/or appropriateness of this method for different age levels.

2. Implementation of the system over a longer period of time should be undertaken to provide additional data on rate of target acquisition as well as data on changes in phoneme error types and categories.

3. A comparison between the results of the Speech Features Rating Scale and the results of spectrographic analysis of the various speech features should be obtained to provide more precise information regarding prosodic errors in general and documentation for use of the more subjective Speech Features Rating Scale in particular.

4. A parent education program for parents of very young hearing impaired

children should emphasize, as part of its speech curricula, techniques for facilitating easy, relaxed speech breathing, phonatory control, and control over duration.

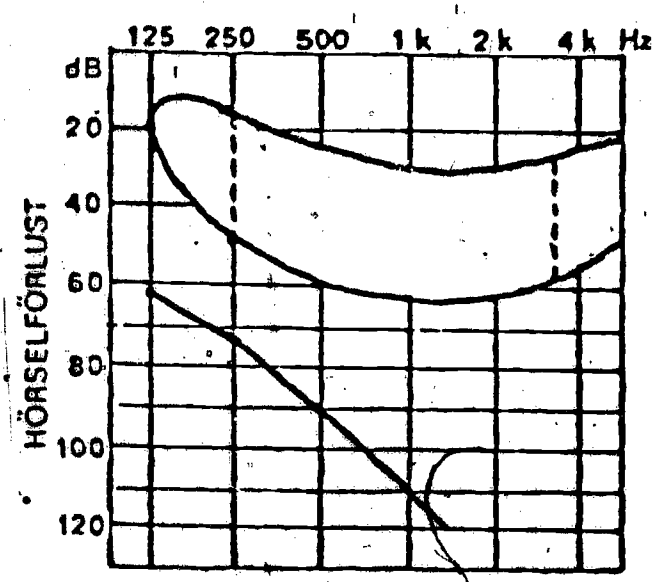
5. Finally, continued pre-service and in-service training is strongly urged to train or update teacher/therapist skills in evaluating the speech of hearing impaired children and planning an appropriate program of treatment. The Ling System of Speech Training should be an integral part of any speech workshop program.

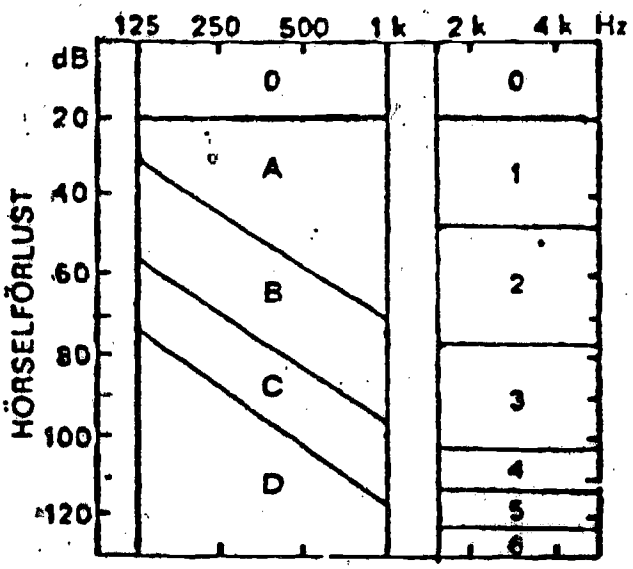
The importance of speech as a mode of communication for the hearing impaired should not be minimized. The Ling System of Speech Training as a hierarchical, sequential and individualized approach is an effective method to use to facilitate the development of intelligible speech in hearing impaired children.

APPENDICES

APPENDIX A

Risberg-Martony Audiometric Classifications*





TALBANANEN anger talets spektrala fördelning på 1 m. avstånd, relaterad till hörselförlusten. Ung. gränser för grundton och frikativor har streckats.

AUDIOGRAMKLASSIFICERING enl. Risberg -75 :
Audiogrammet indelas i olika fält : 5 fält (0 A B C D) i basområdet och 7 fält (0-6) i diskantområdet. Beroende på i vilka fält den hörselskadades hörtröskel ligger, beskriver man typen av hörselnedsättningen.

Basområdet	0	ingen hörselnedsättning
	A	hör lågfrekventa delen av vokaler och kons. på 1 m avstånd.
	B	hör samma som i A men bara med förstärkning
	C	gräns mellan vibration och hörsel
	D	sannolikt finns det ingen hörsel i basområdet
Diskant	0	ingen hörselnedsättning
	1	hör högfrekventa delen av vokaler och de flesta konsonanter på 1 m avstånd
	2	hör sig själv utan hörapparat men knappast konsonanter på 1 m avstånd
	3	hör ej sitt eget tal utan förstärkning, men hörapperaten är till stor hjälp
	4	påvisad hörsel i diskant som i vissa fall kan väl utnyttjas
	5	det kan vara tveksamt om reaktionen är hörsel
	6	sannolikt finns det ingen hörsel i diskanten

APPENDIX B

Instructions to Phonetic Raters for Audiotape I

You are going to hear 30 recorded language samples from two situations. Situation I involves play with the following toys: mother, father, boy, girl, baby, boat. Situation II involves responses to a sequence story about a little boy and his bicycle. A short strip of leader tapes separates each sample. Samples are numbered from 1 to 30. Within each sample segment, Situations I and II are also designated.

You have been given 30 evaluation forms. Use one form for each sample, placing the number of the samples in the upper left corner of the form and your initials where it says "evaluator".

Listen to each sample and write a transcription of each situation in the space provided on the transcription form.

The International Phonetic Alphabet (IPA) should be used for all transcriptions.

Transcribe as broadly as possible. Use the following markings where appropriate:

/x/ - not identifiable substitution

/o/ - omission

/ʔ/ - glottal stop

/n/ - added nasalization

/—/ - unusual prolongation

/h/ - unusual aspirations

/-/ - phoneme production is too short

/d/ - distortion

APPENDIX B-1

Instructions to Phonetic Raters for Audiotape II

You are going to hear 30 recorded samples of 36 utterances each. Each utterance is of three or four words (three to five syllables). A short strip of leader tape separates each utterance from the next. Each utterance is numbered from 1 to 36. Samples are also numbered from 1 to 30.

You have been given 30 phrase List Articulation forms. Use one form for each sample, placing the number of the sample in the upper left hand corner of the form and your initials where it says "evaluator".

Listen to each utterance and write a transcription of the utterance in the space provided on the form. The International Phonetic Alphabet (IPA) should be used for all transcriptions.

Transcribe as broadly as possible. Use the following markings where appropriate:

/x/ - not identifiable substitution

/o/ - omission

/ʔ/ - glottal stop

/n/ - added nasalization

/—/- unusual prolongation

/h/ - unusual aspirations

/-/ - phoneme production is too short.

/d/ - distortion

APPENDIX B-2

Transcription Form for Tape I

Tape Number _____ Transcribed _____

Situation I

Situation II

APPENDIX B-3

Phrase List for Elicited Responses to Pictures

	Phrases		Phonemes: Consonants	Initial	Medial	Final
1.	A RED HOUSE		p	1	2	3
2.	A BLUE TELEPHONE		b	4	5	6
3.	A YELLOW CUP		f	7	8	9
4.	A BROWN GUN		v		10	11
5.	A BROWN KNIFE		θ	12	13	14
6.	A BROWN WINDOW		ð	15	16	17
7.	A YELLOW CHICKEN		m	18	19	20
8.	A GREEN ZIPPER		w	21		
9.	A GRAY SCISSORS		h	22	23	
10.	A YELLOW DUCK		n	24	25	26
11.	A RED SHOVEL		nJ		27	28
12.	A BLUE CAR		d	29	30	31
13.	A WHITE RABBIT		t	32	33	34
14.	A YELLOW LAMP		ʃ	35	36	37
15.	An Orange Carrot		s	38	39	40
16.	A GRAY FEATHER		z	41	42	43
17.	A BLUE BRUSH		l	44	45	46
18.	A RED AIRPLANE		g	47	48	49
19.	SOME RED MATCHES		k	50	51	52
20.	A RED FLAG		J	53		
21.	A WHITE STOVE		tʃ	54	55	56
22.	A RED WAGON		r	57	58	59
23.	A PINK BATHTUB, BATH					

Appendix B3 (con't)

Phrase List Articulation Form

	Phrases	Transcription
24.	A BIG THUMB	
25.	A LITTLE FINGER	
26.	A BLUE PENCIL	
27.	A GRAY CHURCH	
28.	BEHIND THE BABY	
29.	ON THE BOOK	
30.	UNDER THE DRUM	
31.	IN THE HOUSE	
32.	THE GLASS IS SMOOTH	
33.	THE BOY IS SWIMMING	
34.	THE BOY IS FISHING	
35.	THE GIRL IS SLEEPING	
36.	THE BABY IS SITTING	

Vowels

ə	60
i	61
u	62
ɔ	63
ɛ	64
ʊ	65
I	66
æ	67
ʌ	68
ɵ	69
ɑ	70
o	71
ɜ	72

Diphthongs

əu	73
əI	74
ɔI	75
eI	76

APPENDIX H

Speech Target Drill Sheet

Targets: I _____
II _____
III _____
IV _____
V _____
VI _____

Child's Name _____
Week of _____

Date	Drills (attach materials)	Comments	Tutor
Monday	I II III IV V VI		
Tuesday	I II III IV V VI		
Wednesday	I II III IV V VI		
Thursday	I II III IV V VI		
Friday	I II III IV V VI		

APPENDIX I

Instructions to Listeners of Speech Intelligibility and the Suprasegmental Aspects of Speech

You are going to hear 30 recorded speech samples of deaf children. Each child says something different and the speech of these children range from good to very poor.

You have been given 30 Speech Features Rating Scales, use one scale for each sample, placing the number of the sample at the top of the scale and your initials where it says, "Evaluator".

First, listen to the entire sample and make a judgement of the overall speech intelligibility. Under the heading, Speech Intelligibility, on the scale, circle a number from 1 to 5. As you can see, a score of 1 means speech cannot be understood; a score of 5 means completely in elligible. The intervening ratings of 2, 3, and 4 designate progressive gradations between unintelligible to intelligible speech.

Note that the speech of the deaf children will not sound like the speech of normally hearing children. Make your judgements on how intelligible the speech sounds to you.

Replay the sample again, make a judgement regarding the individual Speech Features. Circle a number from 1 to 5 under each speech feature. Number 1 equals a poor level of performance and 5 equals normal or appropriate. The intervening ratings of 2, 3, and 4 designate progressive gradations between poor performance to normal or appropriate. If you are unable to evaluate a particular segment or to make a judgement, circle 0, could not evaluate.

APPENDIX J

Speech Features Rating Scale

Child's Name _____ Date of Taping _____

School _____ Evaluator _____

Segment Evaluated _____

Speech Features

I. Phonatory Control

A. Breath Control:

0	1	2	3	4	5
Could not evaluate	Severe excess or deficiency in air expenditure	Marked excess or deficiency in air expenditure	Moderate excess or deficiency in air expenditure	Slight excess or deficiency in air expenditure	Normal appropriate breath control

B. Pitch Control:

0	1	2	3	4	5
Could not evaluate	Severe extremely inappropriate breaks, fluctuations	Marked Noticeable breaks or fluctuations of large magnitude	Moderate Noticeable breaks or fluctuations of small magnitude	Slight Slight breaks or fluctuations of flat with limited speaking range	Normal satisfactory modulation

II. Duration

A. Vowel Duration:

0	1	2	3	4	5
Could not evaluate	Severe extremely long/short	Marked Much to long/short	Moderate Moderately long/short	Slight Slightly long/short	Normal duration

B. Consonant Duration

0	1	2	3	4	5
Could not evaluate	Severe extremely long/short	Marked Much to long/short	Moderate Moderately long/short	Slight Slightly long/short	Normal duration

C. Syllable Duration:

0	1	2	3	4	5
Could not evaluate	Severe extremely slow or fast	Marked Much to slow or fast	Moderate Moderately slow or fast	Slight Slightly slow or fast	Normal duration

D. Word Duration

0	1	2	3	4	5
Could not evaluate not using words	Severe extremely slow or fast	Marked Much to long or short	Moderate Moderately slow or fast	Slight Slightly slow or fast	Normal duration

E. Utterance Rate:

0	1	2	3	4	5
Could not evaluate not using words	Severe extremely slow/fast	Marked Much to slow/fast rate; definitely interferes with content	Moderate Moderately below/above	Slight Slightly below/ above	Normal duration

III. Continuity of Utterance:

0	1	2	3	4	5
Could not evaluate (grouping/ phrasing)	Severe insufficient continuity, unusual breath groups	Marked breaks in normal pattern	Moderate breaks in normal pattern	Slight breaks in normal pattern	Normal appropriate phrasing and stress

IV. Stress

A. Syllable Stress:

0	1	2	3	4	5
Could not evaluate	Severe inappropriate (too short/long) insufficient inappropriate pitch change	Marked emphasis is hardly ever appropriate	Moderate does not sustain appropriate stress in multi-word	Slight approaching appropriate stress	Normal satisfactory modulations

B. Intonation:

0	1	2	3	4	5
Could not evaluate	Severe extremely inappropriate, extreme variation/ insufficient variation	Marked pitch change hardly ever appropriate	Moderate does not sustain appropriate intonation in short utterance	Slight approaching appropriate pitch change	Normal satisfactory modulations

V. Consonants by Manner

A. Plosiveness Error:

0	1	2	3	4	5
Could not evaluate no plosion	Severe extremely insufficient/ to much plosion; lip smacking; tightness	Marked plosiveness not audible/ too audible, less tense	Moderate some plosion is noted	Slight approaching appropriate amount of plosion	Normal amount of plosion

B. Friction Errors

0	1	2	3	4	5
Could not evaluate no friction	Severe extremely insufficient friction	Marked friction is barely audible	Moderate friction is more noticeable	Slight approaching, appropriate amount of friction	Normal friction

Voice Quality

Circle: breathy/weak, tense, hypernasal, _____.

0	1	2	3	4	5
Could not evaluate	Severe cannot sustain audible tone - all utterances sound hypernasal/tense	Marked the majority of utterances sound breathy, weak, hypernasal, tense	Moderate most of the utterances sound breathy weak, hypernasal, tense	Slight breathiness, tenseness, hypernasality only slightly noticeable, some vowels or consonants appear breathy, tense, hypernasal	Normal quality.

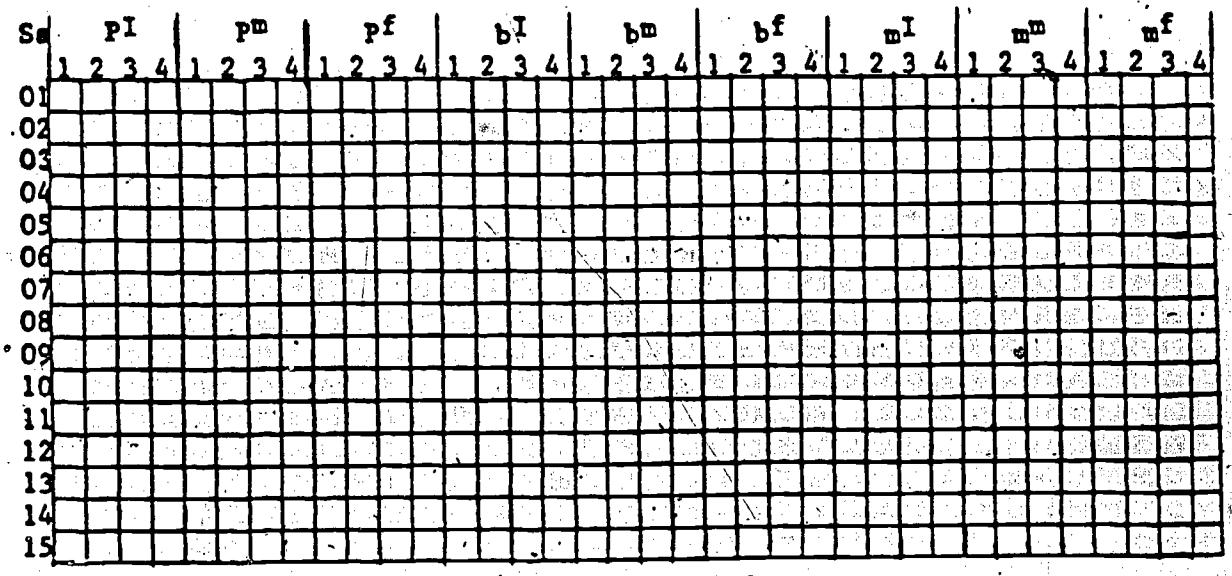
General Intelligibility

0	1	2	3	4	5
Could not evaluate	Speech cannot be understood	Very difficult to understand only isolated words or phrases are intelligible	Partially intelligible; the gist of the content can be understood	Intelligible except for a few words	Speech is completely intelligible

APPENDIX M

Sample of Code Sheet for Recording of Phoneme Errors

Phonemes



Code:

Each phoneme has four spaces. 1234 ☐☐☐☐

Space 1 - is there an error?

0 = no error

1 = error

2 = inconsistent error

Space 2 - Error Type (Appendix I and J)

0 = no error

1 through 6

Space 3 & 4 - Error Category (Appendix I and J)

0 = no error

1 through 11

APPENDIX Q

Correlation Coefficients for Pre and Post Test for Intelligibility Rating and Total Speech Feature Score, Consonant Production in the Initial, Medial and Final Positions, and Vowel and Diphthong Production.

Variable	Intelligibility Rating Pre	Post
Total Speech Features Scores	.91***	.85***
Consonants		
Initial	-.51*	-.60**
Medial	-.61**	-.66**
Final	-.43*	-.61**
Diphthongs	-.59*	-.45*
Vowels	-.45*	-.37*
Hearing Loss	.38	.32
Voice Quality	-.07	.07

* $p < .05$
** $p < .01$
*** $p < .001$