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Sex-Typing of Speech of Prepubertal Children.

George Matthews Marshall IV
Louisiana State University and Agricultural & Mechanical College

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SEX-TYPING OF SPEECH OF PREPUBERTAL CHILDREN

A Dissertation

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George Matthews Marshall IV
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In this study, utterances of prepubertal children were examined for the purpose of limiting and isolating linguistic factors which may be important for aural perception of sex. The subjects were 43 third grade children, 21 boys and 22 girls, who ranged in age from eight years, four months, to nine years. Each of the children produced 19 types of utterances: minimally structured free speech; the sentences "How are you" and "Try try again"; consonant-vowel syllables containing the six stop consonants /p/, /b/, /t/, /d/, /k/, and /g/, in conjunction with the vowel /ɑ/; the same series of stops with the diphthong /aɪ/; and sustained productions of the vowels /i/, /æ/, /ɑ/, and /u/. Tape recordings of the utterances were presented, in random order, to a panel of 16 adult listeners who identified speaker sex after each utterance.

Eighty-six per cent of listener identifications of boys and 87 per cent of identifications of girls were correct on minimally structured free speech, percentages which exactly replicated results obtained in a pilot study. Sex of the children also was identified on the two sentences in which language content was held constant. The

boys were more accurately identified on "Try try again" than they were on "How are you"; in contradistinction, the girls were identified more accurately on "How are you" than on "Try try again."

A number of significant interactions were found between sex and utterance type. Listeners identified boys when they produced any of the four sustained vowels, but correct identifications increased when they produced the low vowels /æ/ and /ɑ/. Conversely, the girls were accurately identified on the high vowels /i/ and /u/; on the low vowels, 50 per cent or less of the identifications were correct.

The boys were correctly identified on all of the consonant-vowel syllables. Girls were correctly identified (at the .05 level of confidence or higher) on four syllables only; on two syllables, /bɑ/ and /gɑ/, less than 50 per cent of the identifications were correct. The substitution of the diphthong /aɪ/ for the vowel /ɑ/ in the syllables increased correct identification for both boys and girls. The increase in identification was greater for the girls. In general, correct identification of the girls was highest when they produced the alveolar stops and voiceless stops. Considerable interaction was observed. The factors of voicing and place of articulation did not significantly affect the identification of boys.

The study, in general, supports the research hypothesis that the sex of prepubertal children can be identified by listeners. Correct identification, however, appears to be differentially related with a number of linguistic factors.

Chapter I

INTRODUCTION

The study of perceptually identifiable differences in the speech of prepubertal boys and girls is heuristic. Perhaps for this reason, the literature contains more speculative comments and opinions than research evidence regarding the subject.

REVIEW OF THE LITERATURE

Moses (1959) postulates that sex differences in speech can be distinguished. He believes that differences in the vocal range develop at four or five years of age. "The basis of the adaption is psychic: the four year old is conscious of his sex and of a broad range of its implications." He maintains that the voices of boys are narrower in range, less modulated, and more aggressive than those of girls (Moses, 1954).

Murphy (1964) does not refer specifically to sex-typing of speech, but he writes that by four or five years of age the child's speech, voice, and communicative affect reveal "his developing personality . . . and self perception (p. 33)."

Studies of laryngeal development and pitch phenomena in childhood have not differentiated the sexes. According to Terracol, Guerrier, and Camps (1956) no significant growth of the vocal folds occurs between age three and puberty. Kaplan (1960, p. 144) agrees and adds: "Prior to about the twelfth year there are no major laryngeal sex differences."

Curry (1940) states that it is very difficult to distinguish the sex of prepubertal children on the basis of voice. Pressman and Kelemen (1955) and Murphy (1964) emphasize the dramatic voice change during puberty, and indicate that prior to that time there are no significant differences in the voices of boys and girls.

Fairbanks and his co-workers (Fairbanks and Herbert, 1949; Fairbanks and Wiley, 1949; Fairbanks, 1950) studied pitch characteristics of seven and eight year old boys and girls. No attempt was made to identify speaker sex by perceptual procedures, but no significant differences were found in the group means for pitch level, total pitch range, 90 per cent pitch range, number of voice breaks, or extent of inflections and shifts. Hollien (1969) also observed that "childrens' fundamental frequency does not seem to be significantly sex differentiated."

Although recognition of childrens' sex from their speech is not explored in the research literature on the development and characteristics of childrens' language,

sex differences in developing language skills are reported. The reported differences focus on rate or degree of speech and language acquisition.

McCarthy's (1954) review of the literature supported the frequently reported observation that girls attain language competency slightly faster than boys when developmental trends are considered. However, the differences are small and do not always favor girls.

Templin (1957) makes the following observation about sex differences in her comprehensive study of language skills:

> The more precocious language development of girls is frequently referred to in the literature of child development. The present study has not entirely substantiated this, especially at the separate age levels. When the performance of boys and girls is compared over the entire age range, girls tend to receive higher scores than the boys, but the differences are not consistent and are only infrequently statistically significant (p. 145).

Winitz (1959) investigated language skills of male and female kindergarten children and states:

> . . . on the basis of the statistical tests employed the hypothesis of no difference between sexes on the major verbalization measures is tenable. Furthermore, the values (obtained on other language measures) indicate that the differences between the sexes are not of sufficient magnitude to justify regarding the groups as essentially different in verbalization skills. . . . (p. 77).

Jersild and Ritzman (1938) found that girls talk more and have a larger vocabulary than boys, but the differences were not statistically significant.

Olson and Koetzle (1936) found that boys talk less but faster than girls. Again the sex differences were small.

When sentences of three to seven year old children were described using a generative model of grammar, Menyuk (1969, p. 19) found no significant correlations between sex and "number of varying syntactic structures". She postulates that the types of grammatical structures which occur are bound by the "rules of a child's grammar" and apparently do not vary as a function of the sex of the child.

PILOT STUDY

In 1969 this writer conducted a pilot study to test the hypothesis that there are perceptual differences in the speech of children, prior to pubescence, which enable listeners to identify a child's sex. A tape-recorded speech sample was obtained in response to a stimulus picture from each child in a third grade class. Listener judgments of the children's speech, rendered by 6 faculty members and 40 students at Louisiana State University, indicated that the sex of the majority of the children was easily identified.

For the faculty member panel of listeners, 86 per cent of listener responses for boys and 87 per cent for girls were correct. The student panel also attained 86

per cent correct responses for the boys. Seventy-four per cent of their responses for girls were correct. The sex of a few of the children was incorrectly identified a high percentage of the time by both panels of listeners. Two children, a boy and a girl, were incorrectly identified by faculty member listeners 100 per cent of the time. Ninety and 92 per cent of the student listeners' responses were incorrect for these two children.

The student listeners also made identifications of sex from printed transcripts of each speech sample. Sixty-nine per cent of the responses for girls and 57 per cent of the responses for boys were correct. Judgments of sex appear to have been made on content differences of a specific topical nature. For example, some judges noted that boys more frequently mentioned "lions" whereas girls mentioned "ballerinas" (subject matter shown in the stimulus picture).

In 1971, Weinberg and Bennett published a study which closely mirrored this writer's pilot study. They tape-recorded 30-second long samples of spontaneous speech from 66 five and six year old children. The recorded sample of each child was heard by 61 adult listeners. Seventy-eight per cent of their responses for male voices, and 71 per cent of their responses for female voices were correct. An additional task of the judges was to identify sex from printed transcripts of each child's

speech. Fifty per cent of the responses were correct, "suggesting that listener responses could be attributed to chance performance." Measures of average fundamental frequency were made and it was concluded that "the extensive overlap in the distribution of mean fundamental frequency characteristics did not account for listener's recognition performance."

Weinberg revealed in personal correspondence that he is extending his research on acoustic characteristics, focusing on the speech of children seven through ten years of age (1970).

There are points for comparison between the writer's pilot study and Weinberg and Bennett's study of speaker sex recognition of five and six year old children (1971). In the Weinberg and Bennett study 78 per cent of listener responses for male subjects were correct. For female speakers, 71 per cent were correct. In the investigator's pilot study of listener identifiability of eight year old children, the panels of faculty members and student listeners each attained 86 per cent correct responses for males. Eighty-seven per cent of the faculty member listeners' responses were correct for females, while 74 per cent of the student listeners' responses for girls were correct. An inference that may be drawn from the relatively greater success attained by the pilot study listeners in identifying either boys or girls is that ability of listeners to identify sex of the

child is related to age of the child--suggesting the emergence in childhood of voice, speech, or language characteristics leading to the perception of "maleness" or "femaleness."

Weinberg and Bennett's listeners consistently misidentified the sex of two boys and three girls. In the pilot study, a boy and a girl were incorrectly identified by all faculty member listeners. These two children were misidentified by 90 and 92 per cent of the student listeners.

PURPOSE OF THE STUDY

The results of the writer's pilot study, in conjunction with the study by Weinberg and Bennett, support the hypothesis that listeners can identify the sex of prepubertal speakers. However, in both studies identifications were made on the basis of a single type of speech sample--minimally structured free speech. There is as yet no research that indicates which of the many parameters of speech of young children may be related with aural perception of sex. In order to limit and identify variables which are related to perception of speaker sex, study is needed of different kinds of speech and vocal phenomena which may contribute to sex-typing. Therefore, the purpose of the study is to examine different kinds of speech and vocal utterances of prepubertal speakers to

determine if certain types of utterances are related to aural identification of sex.

RESEARCH QUESTIONS

1. Can the sex of prepubertal children be identified by listeners when the children produce minimally structured free speech?
2. Can the sex of prepubertal children be identified by listeners when the children produce speech in which language content is held constant?
3. Can the sex of prepubertal children be identified by listeners when the children produce consonant-vowel syllables?
   A. Does diphthongization contribute to identifiability of sex of speakers?
   B. Is presence or absence of voicing of consonants in syllables related to identifiability of sex of speakers?
   C. Is place of articulation of consonants in syllables related to identifiability of sex of speakers?
4. Can the sex of prepubertal children be identified by listeners when the children produce isolated vowels? Are the vowels

differentially related to identifiability of sex?

5. Is the probability of correct listener identifications of prepubertal children related with the sex of the child?
6. Is the identifiability of sex of prepubertal children related with the height or weight of the child?

Chapter II

PROCEDURE

The research questions investigated in this study examine two main factors in relation to aural perception of sex of prepubertal children: differences in sex, and differences in utterance types, and possible interactions between these. Prepubertal boys and girls were obtained to produce an utterance sample composed of different types of speech and vocal utterances. Recordings and listener identifications were made, and the results were statistically analyzed.

SUBJECTS

Forms requesting third-grade volunteers to make a recording of words and speech sounds were distributed to 17 public and 5 Catholic elementary schools in Baton Rouge, Louisiana. Fifty children were scheduled for recording. Forty-three were recorded, 21 boys and 22 girls. (Seven subjects were not used because of failure to keep the appointment, failure on a speech screening test, or anxiety which terminated recording.) Hearing was screened in a

relatively quiet room at hearing levels of 30 dB at 500 Hz and 25 dB at 1000, 2000, and 4000 Hz (ISO 1964 Standard).

The means and ranges for age, height, and weight of the subjects are shown in Table 1 (see Table 10, Appendix A, for sex, age, height, and weight of each of the 43 subjects). The height and weight of the subjects is within the "average zone" for American children according to norms in current use which were compiled by Meredith (1968).

Table 1

Means and Ranges for Age, Height, and Weight of the Subjects

		Boys n=21	Girls n=22
Age (yrs.-mos.)	Mean	8-7	8-8
	Range	8-4 to 9	8-5 to 9
Height (ins.)	Mean	52.76	51.16
	Range	48.50 to 58.50	48.00 to 55.50
Weight (lbs.)	Mean	68.22	65.39
	Range	52.00 to 93.50	46.00 to 82.50

UTTERANCE SAMPLE

The utterance sample contains five divisions. The first four divisions, comprising utterances to be repeated by the subjects, are shown in Table 2. The consonant-vowel and consonant-diphthong syllables in the first two divisions contain the six stop consonants which differ in presence

Table 2

Utterances to be Repeated by the Subjects

Division 1 Consonant-vowel syllables	Division 2 Consonant-diphthong syllables	Division 3 Vowels	Division 4 Sentences
/pɑ/	/paɪ/	/i/	How are you
/bɑ/	/baɪ/	/a/	Try try again
/tɑ/	/taɪ/	/ɑ/	
/dɑ/	/daɪ/	/u/	
/kɑ/	/kaɪ/		
/gɑ/	/gaɪ/		

or absence of voicing and in three places of articulation--bilabial, lingua-alveolar, and lingua-velar. The two series of syllables differ in that the first division contains the low vowel /ɑ/, and the second division contains the diphthong /aɪ/. The third division of utterances contains two high vowels, the front vowel /i/ and the back vowel /u/, and the low vowels, /æ/ and /ɑ/. The fourth division is comprised of two sentences. The sentences were included primarily to establish a condition under which all subjects would produce the same sets of connected speech. There are differences in the phonetic content of the sentences. For example, one sentence is characterized by a backward and upward resonance change in the diphthong /aʊ/, and a forward to back modulation in the glide /ju/. Conversely, the diphthong movement in the second sentence proceeds from a low position toward the high front vowel /i/. However, the stimulus sentences are not comparable for two reasons. The kinds of phonetic material in them are not exactly balanced, and each subject was allowed freedom to produce them without mimicry of prosodic features. The fifth division consists of minimally structured free speech and was elicited in response to a stimulus picture thought to be interesting to both boys and girls. Each subject was allowed 30 seconds, from the time he began speaking, to talk about the picture.

MATERIALS AND EQUIPMENT

A tape recording, approximately three minutes long including inter-stimulus time intervals, was made to instruct the subjects and to present utterances to be repeated. (A printed transcript of the complete recording is shown in Appendix B.) Instructions were presented to the subjects via headphones, the signal being delivered from a Wollensak 1580 tape recorder. The stimulus picture that was used to elicit speech from the children was selected from an encyclopedia and was maintained in a position so that it was easily seen by the subject during recording. Recordings were made in an Industrial Acoustics Company Model 403 Audiometric Examining Room on a Magnecord 1048 magnetic tape recorder. Recordings were made at a speed of 7½ inches per second. An Electro-Voice RE-55 omnidirectional, dynamic microphone was used with the recorder.

An Ampex 2100 magnetic tape recorder with an 8-16 ohm, 15 watt, 45-20,000 Hz Goodmans Maximus 1 speaker was used to present the children's utterances to listeners for identification of speaker sex.

RECORDING, ARRANGEMENT, LISTENER IDENTIFICATION, AND ANALYSIS OF THE UTTERANCES

Recording

From one to three subjects were scheduled for recording at half-hour intervals during a two-day period. The subjects sat as observers while a demonstration subject

demonstrated the tasks to be performed. This procedure was developed to simplify instructions, to conserve time and, hopefully, to allay anxiety. The instruction tape was played at a volume setting previously determined by experience gained with normal hearing children who did not serve as subjects. The headphone jack was inserted only half-way into the recorder, thus allowing the instructions to be heard through the speaker by the subjects being instructed, but through the headphones by the demonstration subject. Periodically, in the time intervals after the demonstrator's utterances, the investigator verbally reinforced instructions to the subjects.

At the completion of the instruction tape the subjects were told that they would follow the same procedure as the demonstration subject except that they would also talk about a picture. The demonstrator was not allowed to describe the picture since no regulation of the subjects' comments was desired. The subjects were then allowed as much time as they wished to preview the picture.

The subject to be recorded was told to "Be sure to speak up so that I can hear you." An unnaturally soft voice might be produced as an effect of air conduction hearing loss resulting from earphone occlusion, or as a result of speaker anxiety. The subject was seated with his head against the back of the chair, and the microphone was adjusted to an estimated six inches. The headphone jack was plugged all the way in, channeling the prerecorded

instructions and stimuli to be repeated into the subject's headphones. The subject's final task was to talk about the stimulus picture.

The children produced 803 of the 817 speech and vocal utterances. Fourteen utterances were not correctly produced. (The desired consonant in a syllable or the desired sustained vowel was not repeated.)

Organization of the Tape-Recorded Material

The 803 tape-recorded utterances were divided into two groups. One group consisted of the consonant-vowel and consonant-diphthong syllables and the sustained vowels. The second group contained the two sentences and the minimally structured free speech sample elicited in response to the stimulus picture. The two groups were randomized separately. Rearrangement of the tape recordings to conform to the random number series within each group was achieved by cutting the tape and splicing the 803 tape segments in random order.

Utterances were separated by a time interval ranging from 6½ to 8½ seconds. (The interval was provided to give listeners time to make and record their judgments of the sex of the speaker.)

Verbal or vocal sounds, such as inadvertent remarks or throat-clearing, were eliminated from the tape recordings. (They might provide additional cues as to speaker sex.) Since freedom of expression in response to the stimulus

picture was desired, no alterations of these recorded speech samples were made.

For presentation to listeners, the magnetic tape recording was divided into four parts as shown in Table 3.

Table 3

Divisions of the Magnetic Tape Recordings for Presentation to Listeners

Part	Utterance type	Number of utterances	Listening time in minutes
1	Syllables and sustained vowels	225	35
2	Syllables and sustained vowels	225	35
3	Syllables and sustained vowels	224	35
4	Sentences and free speech	129	40

Listeners

Sixteen adults, seven males and nine females, who because of vocation or special interests have regularly and frequently associated with children were selected as listeners. Associations ranged from approximately 1 to 13 years with an average of at least 5 years.

Listening sessions were held in a quiet room. The speaker was mounted at ear-level at one end of the room, and the listeners were seated so that each faced and had an unobstructed view of the speaker. Volume setting of the

tape recorder was preselected by experimentation with adult listeners at Special Education Services who did not formally participate in the study.

The following instructions were given to the listeners:

> The recordings contain utterances of boys and girls. You are to identify each speaker as a boy or as a girl by checking the appropriate box beside the utterance number. No adjustment of the tape recorder will be made for individual speakers, nor will utterances be replayed. In the silent interval between speakers I will periodically call out the utterance number. Please do not indicate in any way, to the other listeners, your identification of speaker sex.

The first two parts of the recordings, separated by a rest period, were played in one listening session. A second listening session was scheduled for presentation of the third and fourth parts. Listeners were scheduled as a group when possible, but it was necessary to schedule separate sessions for some listeners.

Data Analyses

Listener judgments of speaker sex for each of the 803 utterances were scored for each of the 16 listeners. The data were subjected to an analysis of variance which utilized the individual degree of freedom technique known as the orthogonal comparison procedure. Pearson r's were obtained to determine if sex identifiability is related to height or weight of speakers. The data were analyzed at the Louisiana State University Computer Center.

Chapter III

RESULTS AND DISCUSSION

The data collected in this study were analyzed to determine if there are differences in sex identification: (1) among utterance types as a function of speaker sex; (2) among utterance types irrespective of speaker sex; (3) as a function of speaker sex; (4) among subjects of the same sex; and (5) among listeners. Results of the analysis of variance are displayed in Table 4. The obtained F values for the first four variables listed above are highly significant, with probabilities considerably less than .01. The F value for the fifth variable is significant at the .01 level of confidence.

Percentages of correct listener identifications by utterance type for each sex are shown in Table 5. Correct identification of sex was sufficiently high on most of the utterances that visual inspection of the data alone permits the conclusion that correct listener identification cannot be attributed to chance. Orthogonal comparisons were made to test for differences in listener identifiability of sex among utterance types to determine

Table 4

Analysis of Variance of Listener Identifications of Sex for the Variables of Utterance Type, Sex, and Listener

Source of Variation	df	Sum of Squares	Mean Square	F
Listener	15	10.05	0.67	2.16*
Sex	1	42.06	42.06	137.46*
Subject/Sex	41	480.42	11.71	38.29*
Error (a)	630	192.84	0.30	
Utterance type	18	44.80	2.48	16.16*
Sex x Utterance type	18	82.17	4.56	29.64*
Error (b)	12,124	1,869.28	0.15	
Total	12,847	2,721.64		

*Significant at the .01 level of confidence

Table 5

Percentage of Correct Listener Identifications by Utterance Type for Each Sex

Item number	Utterance type	Boys	Girls
1	Free speech	86.0	86.6
2	How are you	65.8	76.7
3	Try try again	87.5	59.9
4	/pɑ/	73.1	54.5
5	/bɑ/	73.4	48.0
6	/tɑ/	75.0	60.5
7	/dɑ/	68.4	65.0
8	/kɑ/	77.8	56.2
9	/gɑ/	78.7	49.1
10	/pɑɪ/	77.3	75.0
11	/bɑɪ/	82.5	70.7
12	/tɑɪ/	75.9	72.2
13	/dɑɪ/	80.4	58.5
14	/kɑi/	73.2	70.2
15	/gɑɪ/	75.9	62.8
16	/i/	55.9	81.8
17	/ɑ/	82.1	50.0
18	/ɑ/	83.1	47.7
19	/u/	57.1	69.9
	Overall Means:	75.5	64.0

the relative contributions of utterances (or utterance characteristics) to listener identifiability.

Question 1

Can the sex of prepubertal children be identified by listeners when the children produce minimally structured free speech?

The data presented in Table 5 show that listener identifications of boys and girls from free speech samples were correct approximately 86 per cent of the time. The correct identifications, 86 per cent for the boys and 87 per cent (rounded) for the girls, exactly replicates the correct identifications obtained by the adult listeners in the pilot study. The obtainment of an exact replication of data of this kind, it must be assumed, is based in part on chance. Nevertheless, it reinforces the conclusion that correct listener identifications of the sex of upper-age range prepubertal children on minimally structured free speech can be attained with a high degree of success.

Question 2

Can the sex of prepubertal children be identified when the children produce speech in which language content is held constant?

In listening to item number 2—"How are you", the listeners correctly identified approximately 66

per cent of the boys and 77 per cent of the girls; in listening to item number 3--"Try try again", the listeners correctly identified approximately 87 per cent of the boys and 60 per cent of the girls. The obtained data are shown in Table 5. In brief, the boys were more successfully identified on "Try try again" than they were on "How are you"—the converse was true in the successful identification of girls. The interaction is readily seen in Figure 1.

The difference in the identifiability of the boys on the two sentences was tested through use of an orthogonal comparison, and the results are included in Table 6. The F ratio of the differences in identifiability of the boys on the sentences (item 2 versus item 3) is 51.73.

The difference in the identifiability of the girls on the two sentences was also tested through use of an orthogonal comparison, and the results are shown in conjunction with other comparisons in Table 7. The F ratio of the differences in identifiability of the girls on the sentences (item 2 versus item 3) is 30.79. This ratio, as well as the one for boys reported immediately above, is significant beyond the .01 level of confidence.

Despite the obvious presence of interaction in identification of the sex of prepubertal speakers with

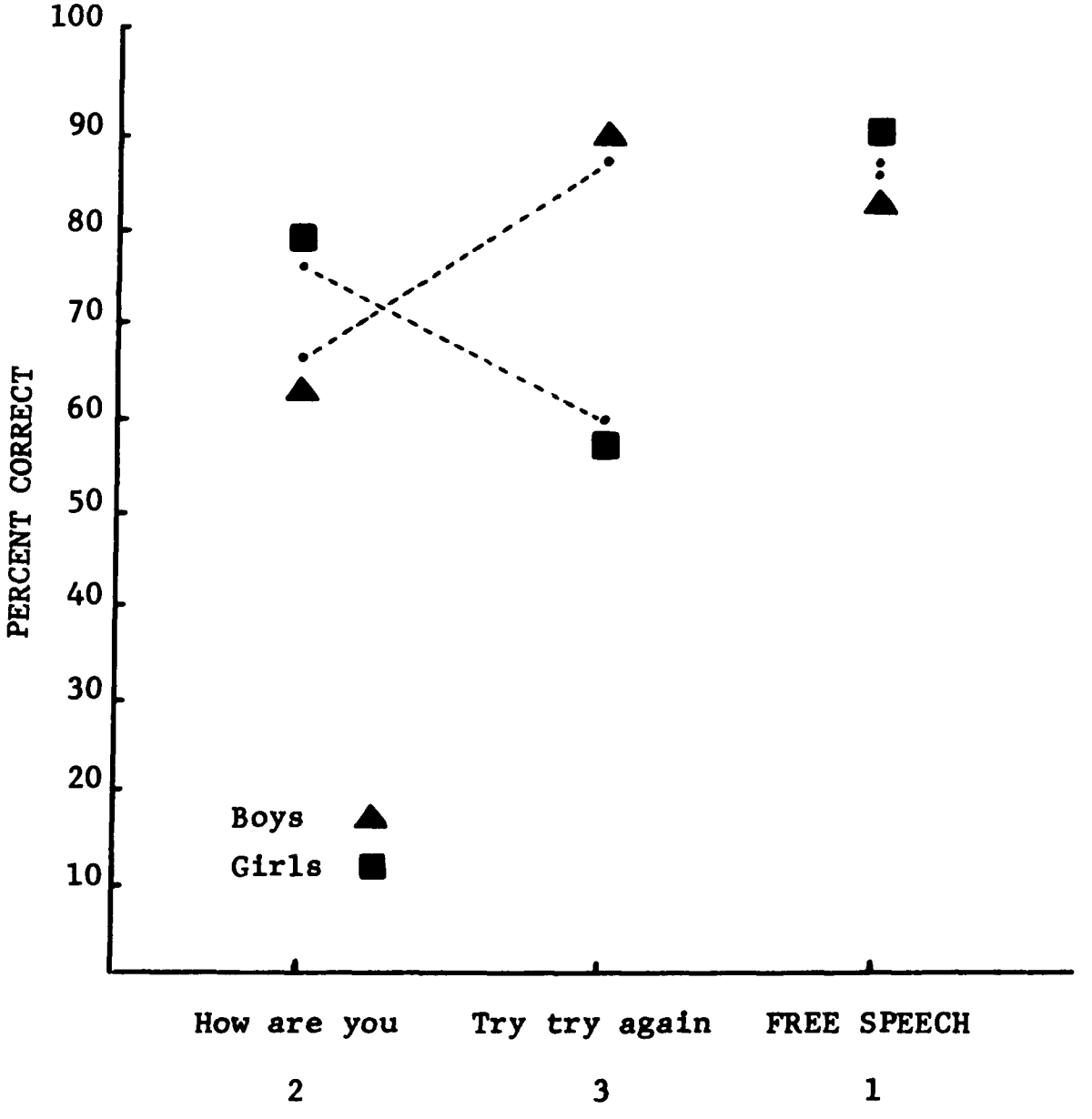

Figure 1. Percentage of Correct Listener Identifications on Sentences and Minimally Structured Free Speech for Boys and Girls

Table 6

Orthogonal Comparisons Among Utterance Types for Boys

Comparisons	Sum of Squares	F
Item Number		
1 versus 2, 3	19804.68	12.84**
2 versus 3	79772.62	51.73**
4, 5, 6, 7, 8, 9 versus 10, 11, 12, 13, 14, 15	9808.53	6.36*
4, 6, 8, 10, 12, 14 versus 5, 7, 9, 11, 13, 15	1366.08	0.88
4, 5, 10, 11 versus 6, 7, 8, 9, 12, 13, 14, 15	795.33	0.51
6, 7, 12, 13 versus 8, 9, 14, 15	1504.46	0.97
16, 19 versus 17, 18	230533.12	149.52**
16 versus 19	216.14	0.14
17 versus 18	163.04	0.10
Total	410320.62	

*Significant at the .05 level of confidence

**Significant at the .01 level of confidence

Table 7

Orthogonal Comparisons Among Utterance Types for Girls

Comparisons	Sum of Squares	F
Item Number		
1 versus 2, 3	75658.68	49.07**
2 versus 3	47478.96	30.79**
4, 5, 6, 7, 8, 9 versus 10, 11, 12, 13, 14, 15	162290.87	105.26**
4, 6, 8, 10, 12, 14 versus 5, 7, 9, 11, 13, 15	33335.75	21.62**
4, 5, 10, 11 versus 6, 7, 8, 9, 12, 13, 14, 15	57.22	0.03
6, 7, 12, 13 versus 8, 9, 14, 15	13574.82	8.80**
16, 19 versus 17, 18	246194.93	159.67**
16 versus 19	24060.19	15.60**
17 versus 18	872.91	0.56
Total	735299.56	

**Significant at the .01 level of confidence

the structured sentences employed in this study, the research question must be answered affirmatively, for the reason that even the lowest identification of the sentences (60 per cent for girls on "Try try again) is well above chance possibility. The t for this identification is 3.83, with 351 degrees of freedom, and is significant at the .01 level of confidence.

The difference in the identifiability of the boys when using free speech and when producing the predesignated sentences was tested with an orthogonal comparison and the results are shown in Table 6. The comparison of item 1 (free speech) with items 2 and 3 yielded an F ratio of 12.84. This ratio is significant at the .01 level of confidence. The similar comparison for girls is shown in Table 7; here, the obtained F ratio is 49.07, also significant at the .01 level.

In brief, the set of comparisons indicated that the sex of prepubertal children is more readily identifiable on minimally structured free speech than on the sentences. Furthermore, the interaction between sex and utterance type strongly suggests that a <u>particular</u> speech sample may contain cues which enhance the probability of correct listener identification of one sex but not of the other.

Question 3

Can the sex of prepubertal children be identified by listeners when the children produce consonant-vowel syllables?

The correct listener identifications of the sex of the children when each child produced consonant-vowel syllables is shown in Table 5. It was recognized that some of the obtained data possibly reflect only chance deviation from the expected 50 per cent correct identification and, accordingly, t-tests were conducted and the results are reported as needed. All data with regard to the identification of boys through use of the consonant-vowel syllables tested in this study, for example, are significant at the .01 level of confidence.

In contrast, with regard to the identification of girls through use of the consonant-vowel syllables tested in this study, in only two syllables, /tɑ/ 60.5 per cent and /dɑ/ 65.0 per cent, was correct identification sufficiently high so as to be significant at the .01 level of confidence. In the identification of girls, two syllables, /pɑ/ 55 per cent and /kɑ/ 56 per cent, produced correct identifications sufficiently high so as to be significant at the .05 level of confidence. Less than 50 per cent of the listener identifications were correct when the girls produced /bɑ/ 48 per cent and /gɑ/ 49 per cent.

A comparison of the data obtained in this portion of the study is shown in Figure 2. Inspection of the research data as displayed in Figure 2 strongly suggests the research hypothesis is supported in the main but that further research is indicated before broad generalizations are made.

Question 3 A

Does diphthongization contribute to identifiability of the sex of prepubertal children?

The differences in the identifications when the children produced consonant-vowel syllables (items 4-9) and consonant-diphthong syllables (items 10-15) were examined through the use of orthogonal comparisons.

Both boys and girls were identified more correctly when they produced consonant-diphthong syllables than when they produced the consonant-vowel syllables. The orthogonal comparison for boys, shown in Table 6, yielded an F ratio of 6.36, which is significant at the .05 level of confidence. The comparison for the girls is reported in Table 7. For this comparison, the F is 105.26 which is significant beyond the .01 level of confidence.

Figure 2 helps to make clear the kinds of differences found in this study. This figure helps in the interpretation of the F's reported above. It can be

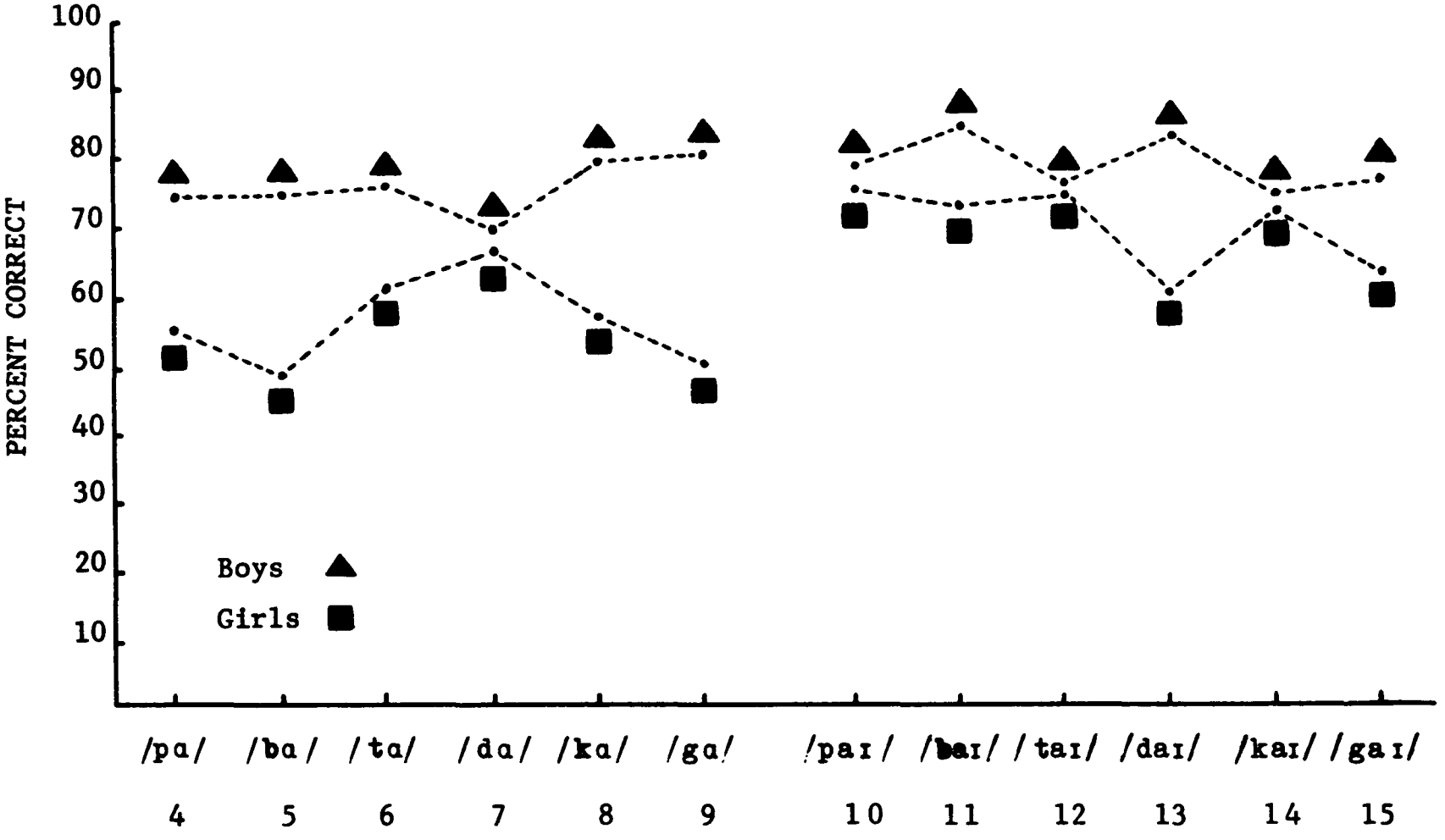

Figure 2. Percentage of Correct Listener Identifications on Consonant-Vowel and Consonant-Diphthong Syllables for Boys and Girls

seen that although the employment of diphthongs led to greater improvement in listener identification of the girls, the boys still were identified more correctly than were the girls.

On the basis of these data, the research question is answered affirmatively, with the necessary reservation for the reason that only one diphthong was examined in the study.

Question 3 B

Is the presence or absence of voicing of consonants in syllables related to identifiability of sex of speakers?

The utterances with voiceless consonants are identified by the even-numbered items in the set of 4-15. The utterances containing voiced consonants are identified by odd numbers in the same set. The pertinent orthogonal comparisons presented in Table 6 and 7, therefore, concern the comparison of items 4, 6, 8, 10, 12, 14 versus 5, 7, 9, 11, 13, 15.

The F ratio of .88 for boys, shown in Table 6, is not significant and indicates that voicing of consonants neither helps nor decreases accuracy in the identification of prepubertal boys.

The F ratio of 21.62 for girls, shown in Table 7, in contrast, is significant beyond the .01 level of

confidence. Inspection of the data presented in Table 5 shows that the listener identifications of girls were more accurate on the syllables which contained voiceless consonants.

On the basis of the above findings, the research question appears to be answered best as follows: yes, when the prepubertal speaker is a girl; no, when the speaker is a boy.

Question 3 C

Is place of articulation of consonants in syllables related to identifiability of sex of speakers?

This question was studied through employment of orthogonal comparisons. Table 6 contains the summary of findings for the boys and Table 7 for the girls. The bilabial consonants /p/ and /b/, in conjunction with the vowel /ɑ/ and the diphthong /aɪ/ produced item numbers 4, 5, 10, 11.

The lingua-alveolar consonants /t/ and /d/, in conjunction with /ɑ/ and /aɪ/ produced items 6, 7, 12, 13.

The lingua-velar consonants /k/ and /g/, combined with /ɑ/ and /aɪ/ produced items 8, 9, 14, 15.

The comparisons for boys shown in Table 6 and replicated in Table 7, then, consist simply of a comparison of one of the subsets listed above with one of the other subsets or with the other subsets combined.

Through employment of this standard procedure, it becomes obvious that place of articulation is not a significant factor in the identification of boys. However, it can be seen in Table 7 that differences in the identification of girls occurred when they used lingua-alveolar consonants. Examination of the data in Table 5 shows that the identification of girls was more accurate when they produced the lingua-alveolar stops.

Question 4

Can the sex of prepubertal children be identified by listeners when the children produce isolated vowels? Are the vowels differentially related to the identifiability of sex?

The mean data with regard to this particular research question are shown as items 16-19 in Table 5. When the boys produced sustained low vowels /a/ and /ɑ/, 82 and 83 per cent respectively of the listener identifications were correct; when the boys produced sustained high vowels /i/ and /u/, the percentage of correct identifications dropped to 56 and 57 per cent respectively. Because the latter percentages appear to approach chance expectation, their significance was tested through the use of t- tests. The 56 per cent correct identifications found when the boys sustained /i/ produces a t of 2.22 with 335 degrees of freedom: the 57 per cent correct

identification when the boys sustained /u/ produces a t of 2.19 with 239 degrees of freedom. Both t's are significant at the .05 level of confidence. In brief, the listeners were able to identify the sex of boys when hearing any one of the four vowels tested; however, accuracy of listener identification was considerably higher when the low vowels /a/ and /ɑ/ were produced.

The results obtained when girls were the subjects were diametrically opposed to the above findings in several important respects. When the girls produced the sustained low vowels /a/ and /ɑ/, 50 and 48 per cent of the girls were correctly identified. These results are obviously in the region of chance expectation. When the girls produced the high vowels /i/ and /u/, the percentage of correct identifications improved markedly: to 82 per cent when they produced /i/ and to 70 per cent when they produced /u/. In brief, the listeners were able to identify the sex of girls when hearing /i/ and /u/ and their ability to identify the sex of girls decreased to chance expectation when hearing /a/ and /ɑ/.

The overall pattern in the relationships observed above is shown graphically in Figure 3. The interaction seen in this figure was tested through orthogonal comparisons.

The comparisons of the correct identifications when the boys produced the sustained vowels are found in

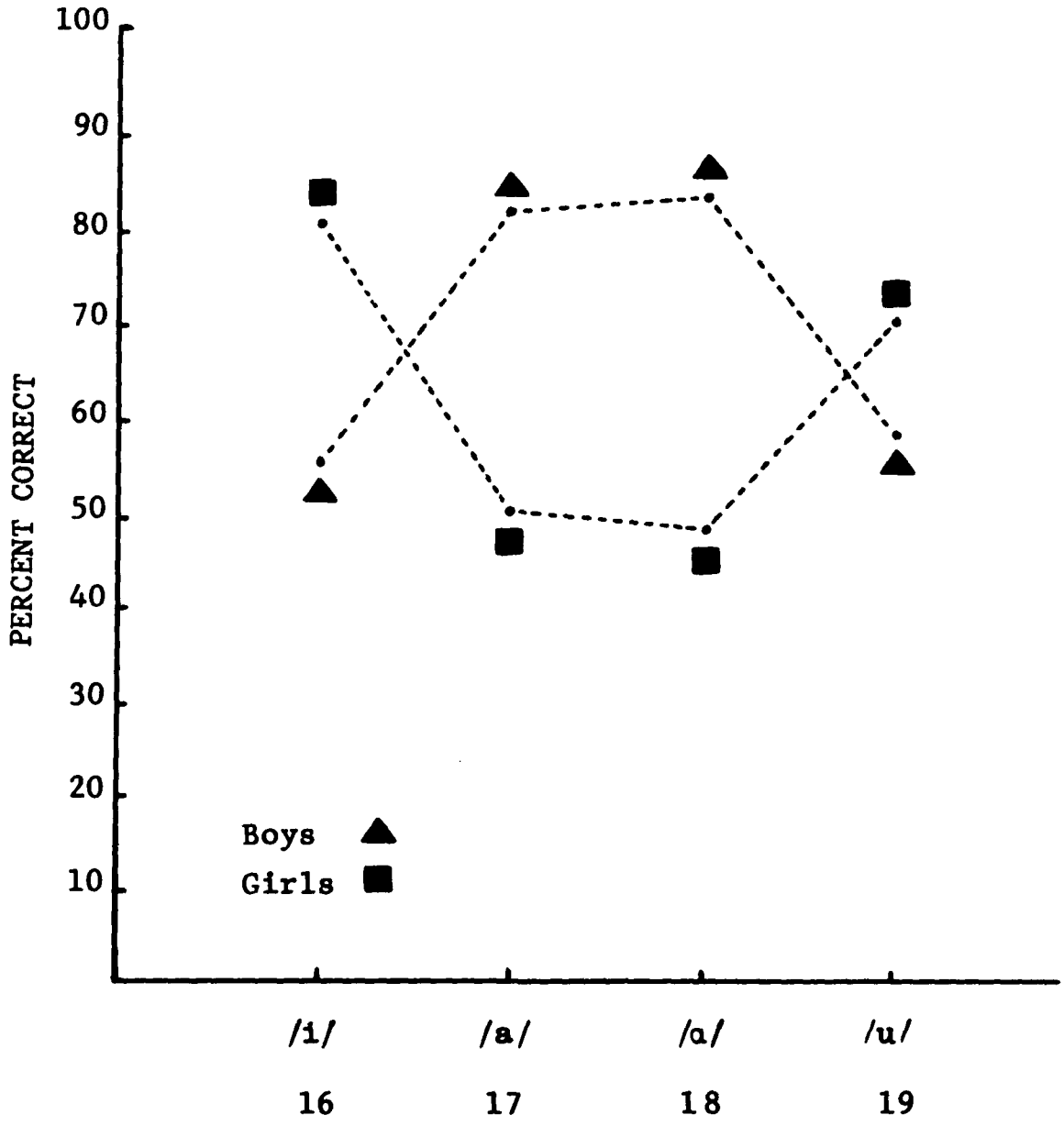

Figure 3. Percentage of Correct Listener Identifications on Sustained Vowels for Boys and Girls

Table 6. The correct identifications when /i/ and /u/ (items 16 and 19) were produced were compared with identifications when /a/ and /ɑ/ (items 17 and 18) were produced. The obtained F ratio of 149.52 is significant beyond the .01 level of confidence. As visual inspection of Figure 3 suggests, the difference in identification when /a/ (item 17) and /ɑ/ (item 18) were compared is not significant; similarly, the difference in identification when the boys produced /i/ (item 16) and /u/ (Item 19) is not significant. The comparisons of the correct identifications when the girls produced the sustained vowels are found in Table 7. The identifications made when the girls produced /i/ and /u/ (items 16 and 19) were compared with those for the low vowels (items 17 and 18). The obtained F ratio (159.67) is significant beyond the .01 level of confidence. The difference in identification when the girls produced /a/ and /ɑ/, as was found with the boys, is not significant. In the final comparison, it was found that the listener identification of 82 per cent when girls produced /i/ is significantly higher than the 70 per cent correct identification when the girls produced /u/.

In brief, the findings relative to the identifiability of children when the utterances consist of sustained low and high vowels are completely unexpected and reveal an inversion of results in the perception of

girls and boys. A presentation of hypotheses concerning why boys are identified with relatively high (82 and 83 per cent) accuracy from low vowel sounds and with less accuracy from high vowel sounds and the diametrically opposite findings for girls should be withheld until the underlying psycho-acoustic phenomena are carefully studied.

A word of caution should, perhaps, be inserted, to the effect that the superficial resemblance of Figure 3 to the vowel quadrilateral can be viewed only as fortuitous at the present time. The vertical dimension of Figure 3 concerns accuracy of identification and the horizontal dimension a set of qualitative classes. While it is true that the classes /i/, /æ/, /ɑ/, and /u/ are arranged in the figure in general conformance with the physiological front-to-back classification system, conjecture with regard to the fundamental reason for the findings observed in this study should await a detailed acoustical analysis of the phenomenon.

Question 5

Is the probability of correct listener identifications of prepubertal children related with the sex of the child?

The overall means for correct identification of the boys and girls who served as subjects in this study

are presented in Table 5: the overall correct identifications for boys was 75.5 per cent, for girls it was 64 per cent. The F for this main factor is presented in Table 4. The F of 137.46 is significant beyond the .01 level of confidence.

Generalizations concerning main factors must be tempered when a set of data show the presence of significant sub-factors and interactions. In this study thus far, it has been shown that correct listener identification of the sex of prepubertal children is partially related with differences in utterances.

Additional data, included in Table 8, indicate that a considerable difference in identifiability of particular children seems to exist. In brief, it appears that the sex of some children can be easily identified by listeners and that the converse is true for other children. Although the data is limited for a discussion of individual differences in subjects, it may be observed that within the subjects for this study, one young boy and five young girls were identified correctly less than 50 per cent of the time.

In general, the finding in this study that boys appear to be identified more accurately than girls replicates the results attained by Weinberg and Bennett (1971), in their study of five and six year old children.

Table 8

Percentage of Correct Listener Identifications for Each Subject

Boys		Girls	
Subject number	Per cent correct	Subject number	Per cent correct
6	98.6	9	95.7
14	97.9	23	91.8
3	96.7	10	90.8
26	95.1	42	83.2
38	87.9	20	82.6
29	87.5	39	81.2
15	87.5	18	78.3
30	87.2	35	74.7
5	85.1	17	72.4
4	84.5	43	66.1
28	81.6	24	66.4
13	79.9	37	63.2
31	78.9	12	57.6
41	75.3	2	56.6
36	68.1	8	55.9
40	65.8	19	54.6
25	53.9	22	51.3
16	53.3	21	41.8
32	52.8	34	40.8
33	51.0	7	40.5
11	22.0	1	40.5
		27	21.7
	Mean: 75.5		Mean: 64.0

Question 6

Is the identifiability of sex of prepubertal children related with the height or weight of the child?

Pearson product-moment correlation coefficients were obtained for study of the above question. The Pearson r for the correlation between height and identification of sex was .22. The r for the correlation between weight and identification was .19. With 41 degrees of freedom, the obtained r's are not significant. The magnitude of the r's suggest that it may not be worthwhile to pursue this particular research question in future research studies.

The possibility that listeners differ in ability to identify the sex of prepubertal children was not included as a research question in this study. Consequently, for pragmatic reasons, it was possible to limit the number of listeners for this study to 16. The percentage of correct identifications made by each of the listeners is shown in Table 9. Inspection of these data reveals that the percentage of correct identifications ranged from a low of 62 per cent to a high of 73 per cent. At first glance, the data suggest that there was relatively little difference within the group of listeners employed for this study. The question was tested, however, in the analysis of variance. The F for listeners of 2.16,

Table 9

Percentage of Correct Sex Identifications Attained by Each Listener

Listener number	Per cent correct	Listener number	Per cent correct
1	65.8	9	70.2
2	71.2	10	70.1
3	70.6	11	72.7
4	70.5	12	65.3
5	71.7	13	69.0
6	73.3	14	70.1
7	71.2	15	69.9
8	62.3	16	68.6

with 15 degrees of freedom, as reported in Table 4, is significant at the .01 level of confidence. It must be concluded, therefore, that listener differences for this particular task exist. The amount of control for this factor in future studies can be determined by research after examination of these data.

Chapter IV

SUMMARY AND CONCLUSIONS

The hypothesis that listeners can identify the sex of prepubertal speakers is found frequently in the literature. Researchers have examined some of the physical, physiological and linguistic aspects of the speech of young children and have had little success in providing an explanation for the differences in identifiability of boys and girls.

The purpose of this study has been to re-examine the general hypothesis as a perceptual problem in linguistics. A sample of eight year old children provided a set of utterances which included: minimally structured free speech, short sentences with language content held constant and subsets of consonant-vowel syllables which contain differences in place of articulation and voicing. The children also provided a subset of sustained vowel sounds, and a subset of consonant-diphthong syllables. The purpose of the study, in brief, has been to delimit the kinds of linguistic factors on a molecular level which are significant in the aural identification of the sex of prepubertal children.

The sample of children employed as speakers contained 21 boys and 22 girls. Each child produced a set of 19 utterances: minimally structured free speech; the sentences "How are you" and "Try try again"; the sustained vowels /i/, /æ/, /ɑ/, and /u/; the consonant-vowel syllables /pɑ/, /bɑ/, /tɑ/, /dɑ/, /kɑ/, /gɑ/ and the syllables /paɪ/, /baɪ/, /taɪ/, /daɪ/, /kaɪ/, and /gaɪ/. The utterances were tape-recorded, randomized and spliced together on four master tapes for presentation to a panel of 16 adult listeners. A listener's task was simply to identify the sex of the speaker after hearing each utterance. Each decision was arrived at independently. The basic data consisted of the percentage of correct identifications obtained for each kind and sub-class of utterance.

The general hypothesis that listeners can identify the sex of prepubertal speakers was supported by the data obtained in this study. When the utterances consisted of minimally structured free speech, 86 per cent of the boys and 87 per cent of the girls were correctly identified. The data, presumably by chance, exactly replicated results obtained by the researcher in a pilot study for this investigation. Weinberg and Bennett (1971) reported 78 per cent accuracy in the identification of male voices and 71 per cent accuracy in the identification of female voices when five and six year old children produced free

speech. The difference in identifiability in the two studies may possibly be related to the difference in the age of the subjects.

The major contribution of the present study is that the identifiability of prepubertal speakers appears to be differentially related with some of the linguistic classes and that interactions are found between sex and certain linguistic features.

A finding which was completely unexpected is that boys are highly identifiable when they produce the sustained low vowels /æ/ and /ɑ/ (82 and 83 per cent, respectively of the listener identifications were correct) and that the percentage of correct identifications dropped to 56 and 57 per cent when the boys produced sustained /i/ and /u/ vowels. Identification of the boys on the low vowels was significant at the .01 level of confidence and was significant at the .05 level on the high vowels.

The findings with regard to the identification of girls are diametrically opposed to the above results. When the girls produced sustained low vowels /æ/ and /ɑ/, 50 and 48 per cent of the girls were correctly identified. These results are in the region of chance expectation. Conversely, when the girls produced the high vowels /i/ and /u/, 82 and 70 per cent of the girls were identified correctly. It is suggested that

interpretation of the above findings should be withheld until the underlying psycho-acoustic phenomena are carefully studied.

Study of the effect of diphthongization on the identifiability of the sex of prepubertal children was limited in this investigation to differences which occurred when the diphthong /aɪ/ was substituted for the vowel /ɑ/ in the set of six consonant-vowel syllables. The percentage of correct identifications for both boys and girls increased when this substitution was made. Although employment of the diphthong led to greater improvement in listener identification of the girls, the boys still were identified more correctly than were the girls. A generalization that this finding may apply to all diphthongs cannot be made, for the reason that only one diphthong was examined in this study.

Conclusions with regard to the importance of the other linguistic features which were examined must be guarded, for numerous interactions were discovered. For example, correct identifications of the boys were made when they produced any of the consonant-vowel syllables. The percentage of correct identifications ranged from 68 per cent for /dɑ/ to 79 per cent for /gɑ/. In contrast, correct identifications of the girls (at the .01 level of confidence) were found only when they produced the alveolar stops /tɑ/ and /dɑ/. It also

developed that the best consonant-vowel utterance for the boys /gɑ/ (79 per cent identification) was the poorest for identification of the girls (49 per cent).

Investigation of the contribution of voicing of consonants to identification of the sex of the child also produced mixed findings. The presence or absence of voicing in consonants appears neither to help nor to decrease accuracy in the identification of prepubertal boys. Accuracy in the identification of prepubertal girls was higher when the consonant-vowel syllables contained voiceless consonants. In the face of this kind of interaction, generalizing statements must be made carefully.

On the basis of this perceptual study, it appears that many utterances of upper-age range prepubertal children are laden, to varying degrees, with cues that serve to identify speaker sex.

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APPENDIXES

APPENDIX A

Table 10. Sex, Age, Height, and Weight of Each of the 43 Subjects

Subject Number	Sex	Age (yrs.-mos.)	Height (ins.)	Weight (lbs.)	Subject Number	Sex	Age (yrs.-mos.)	Height (ins.)	Weight (lbs.)
1	Female	8-6	49.00	62.00	23	Female	9	48.00	50.00
2	Female	8-5	51.50	61.00	24	Female	8-5	54.25	77.50
3	Male	9	57.25	78.00	25	Male	8-8	53.00	61.00
4	Male	8-7	52.00	63.50	26	Male	8-9	58.50	79.50
5	Male	8-11	51.00	57.50	27	Female	8-8	50.25	62.50
6	Male	8-11	53.50	93.00	28	Male	8-8	54.50	93.50
7	Female	8-10	51.75	78.00	29	Male	8-6	50.00	57.00
8	Female	8-9	48.50	55.00	30	Male	8-9	56.50	76.50
9	Female	8-7	50.25	66.00	31	Male	8-9	50.50	63.00
10	Female	8-8	48.00	62.50	32	Male	8-4	52.75	72.00
11	Male	8-10	50.00	57.50	33	Male	8-5	49.00	53.50
12	Female	8-9	55.50	76.50	34	Female	8-9	53.25	62.00
13	Male	8-9	53.25	70.00	35	Female	9	50.50	82.00
14	Male	8-10	55.50	72.50	36	Male	8-5	48.50	52.00
15	Male	8-6	53.75	63.00	37	Female	8-10	50.00	81.50
16	Male	8-8	54.00	74.50	38	Male	8-11	50.25	62.00
17	Female	8-9	49.25	51.00	39	Female	9	55.00	72.00
18	Female	8-10	49.00	56.00	40	Male	8-5	50.75	53.50
19	Female	8-10	48.75	62.50	41	Male	8-5	53.50	79.50
20	Female	8-11	52.50	68.00	42	Female	8-7	50.50	46.00
21	Female	8-11	55.25	64.00	43	Female	8-11	53.00	82.50
22	Female	8-10	51.50	60.00					

APPENDIX B

Transcript of the Instructional Tape Recording

All right, all you need to do is listen carefully and make the sounds I make, and say the words I say. Ready, let's begin:

Say /pɑ/	Say /paɪ/
Say /dɑ/	Say /daɪ/
Say /kɑ/	Say /kaɪ/
Say /bɑ/	Say /baɪ/
Say /tɑ/	Say /taɪ/
Say /gɑ/	Say /gaɪ/

Now we will make some long sounds. Make them as long as mine are. Ready, let's begin:

Say /i/
Say /a/
Say /ɑ/
Say /u/

Now we will say some words. Ready, let's begin:

Say, "How are you"
Now say, "Try try again"

Now I want you to tell me all about the picture. What's happening in the picture? What's going on? You can tell a story about it. Tell me all about the picture. Begin right now!

VITA OF GEORGE M. MARSHALL IV

Born:	January 14, 1930 Natchez, Mississippi
Parents:	George M. Marshall Margaret Persell Marshall
Married:	Mary Powell Marshall
Military Service:	January, 1951 - December, 1954 United States Air Force
Education:	
High School:	Natchez High School Natchez, Mississippi
Undergraduate:	B.A., January, 1959 University of Mississippi Oxford, Mississippi Major: English
Graduate:	M.S., January, 1964 Vanderbilt University Nashville, Tennessee Major: Speech Pathology and Audiology
Professional Experience:	
Public School Teacher:	September, 1960 - August, 1962 Natchez-Adams County Schools Natchez, Mississippi
Speech Clinician:	January, 1964 - August, 1964 Bill Wilkerson Hearing and Speech Center Nashville, Tennessee
Speech and Hearing Consultant:	September, 1966 - present Special Education Services College of Education Louisiana State University Baton Rouge, Louisiana

EXAMINATION AND THESIS REPORT

Candidate: George Matthews Marshall, IV

Major Field: Speech

Title of Thesis: Sex-Typing of Speech of Prepubertal Children

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

May 5, 1972