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Pitch of the voice in certain speaking and reading activities among elementary school children

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PITCH OF THE VOICE IN CERTAIN SPEAKING AND READING ACTIVITIES AMONG ELEMENTARY SCHOOL CHILDREN

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CHAPTER I

THE PROBLEM

Introduction

Speaking and oral reading are processes which, until recently, seemed to offer few possibilities of precise objective analysis. Vocal standards have been set up according to tastes of experienced listeners, and methods for producing effective speaking and oral reading have been based necessarily on impressions received by the ear.

It is frequently desirable in studying the human voice to isolate one or more of the major tonal functions for analysis. Black suggests that a comparison of tones start with a consideration of pitch.[1] The belief was expressed by Skinner that pitch is a phenomenon far too complex to be reported by the human auditory mechanism.[2] It is well-known that pitch is not perceived per se since the listener is engaged in a reception of words and ideas and is not immediately conscious of the pitch element accompanying them. Pitch measuring devices provide objectivity not found in perceptual judgment of vocal pitch. The present study of the vocal pitches of children was made possible through the use

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[1] Henry N. Black, An Introductory Course in College Physics, p. 565. New York: The Macmillan Co., 1935.

[2] E. Ray Skinner, "A Calibrated Recording and Analysis of Pitch, Force, and Quality of Vocal Tones Expressing Happiness and Sadness," Speech Monographs, Research Annual, II (October, 1935), 81.

of the Purdue Pitch Meter, an improved device for objective analysis of the voice.[3]

Statement of the Problem

The problem of this study was to provide from objective pitch measurements an answer to the question: What does a child do with his vocal pitch in certain speaking and oral reading activities?

The purposes of the study were:

1. To locate in terms of fundamental frequencies the average pitch levels used by children in speaking, in easy and difficult reading, and in unaided recall of easy and difficult reading.
2. To compare the mean vocal pitches of the five oral activities noted above.
3. To report average pitch levels significantly related to differences in sex, intelligence, grade placement, and educational achievement for the groups studied.

Importance of the Study

It is hoped that the findings of this study will contribute to a functional concept of vocal pitch which can become a basis for improving instruction, performance, and evaluation in oral reading. Due to its great complexity, the voice has a tendency to elude exact analysis. It is, therefore, believed that a study which adds to the basic information about the voice can be considered a distinct and valuable contribu-

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[3] M. E. Dempsey and others, "Purdue Pitch Meter--A Direct Reading Fundamental Frequency Analyzer," Journal of Speech and Hearing Disorders, XV (June, 1950), 135-141.

tion.

Objective studies of the voice supply a valuable check on conjectures and theories that have been advanced, and reveal basic facts regarding subtle changes in sound wave patterns that are heard subjectively only as total effects. This investigation is admittedly exploratory, although in carrying it out there was the hope that previous findings in this field of research might be verified and that problems for further study might be suggested.

Definition of Terms

For the purposes of reporting the results of this study and also of discussing the findings of previous research, the writer has used the following terms to describe the physical operation of voiced sound with the meanings as indicated:

cps: cycles per second

cycle: one complete set of recurrent values of a periodic quantity comprised of alternate condensations and rarefactions[4]

fundamental frequency: the number of vibrations per second made by the sounding body, determined by counting the number of wave crests passing a fixed point in one second[5]

harmonic: a secondary vibration caused when an apparatus is vibrating in segments; overtone[6]

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[4] H. A. Frederick, "American Tentative Standard Acoustical Vocabulary," *Journal of the Acoustical Society of America*, IX (July, 1937), 60.

[5] Black, *op. cit.*, p. 559.

[6] *Ibid.*, p. 560.

inflection: a frequency modulation in a given direction without interruption of phonation[7]

interval: difference in pitch between two tones[8]

phonation: uninterrupted sound from the vocal cords[9]

pitch: highness or lowness of tone caused by vibrations which give rise to sound waves in the space surrounding the vibrating apparatus[10]

pitch level: number of cps of the sound waves

pitch range: tonal steps occurring between the highest and lowest pitches used

semitone: interval on a musical scale approximately equal to half a whole tone

shift: change in pitch measured between the last pitch in a given phonation and the first pitch measured in the phonation following[11]

sound wave: vibration in an elastic medium taking place in the direction of propagation that results in an alteration of pressure in the medium; the longitudinal compression waves are made up of alternate

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[7]Grant Fairbanks and Wilbert Pronovost, "An Experimental Study of the Pitch Characteristics of the Voice During the Expression of Emotion," Speech Monographs, Research Annual, VI (1939), 95.

[8]Frederick, op. cit., p. 70.

[9]Fairbanks and Pronovost, loc. cit.

[10]Isaac K. Funk (ed.), Funk and Wagnall's New Standard Dictionary of the English Language, pp. 1886-87. New York: Funk and Wagnall's Company, 1949.

[11]Fairbanks and Pronovost, op. cit., p. 98.

condensations and rarefactions[12]

<u>voice break</u>: abrupt, involuntary pitch inflection

<u>voice key</u>: average pitch level for a voice[13]

<u>whole tone</u>: approximately one sixth of the interval between the key tone and its octave in a musical scale.

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[12] Semi J. Begun, <u>Magnetic Recording</u>, p. 16. New York: Rinehart Books, Inc., 1949.

[13] Milton Cowan, "Pitch and Intensity Characteristics of Stage Speech," <u>Archives of Speech</u>, III (December, 1936), 65.

CHAPTER II

REVIEW OF THE LITERATURE

This comprehensive review brings together information from three arbitrary divisions of vocal pitch research: (1) observation or speculative research, (2) experimental or laboratory research, and (3) techniques for objective studies of vocal pitch.

Observation or Speculative Research

In 1930 Alfred R. Root published an historical survey of observational studies of the pitch factor in speech in which he presented facts to show that pitch characteristics of the voice were observed, interpreted, and reported before the time of Christ. Vocal pitch theories have been a major force affecting the style of elocution. For example, the speech teachers of the nineteenth century were influenced by the idea that pitch of voice was governed by pure musical laws. Music and speech were thought to differ only in the fact that speech utilized steady tonal changes while music used discrete tonal steps. As a result, speech was fettered to a system of musical terms and notation to show various intervals, scales, and vanishing points according to the meaning being expressed.

Observations upon the registers of male and female voices have been made repeatedly by writers from the early Greek rhetoricians down to the present. These empirical descriptions have pointed out that the pitch level for a given individual changes from year to year following a curve which characterizes other functions: In childhood the register is high, decreased in adolescence, still lower during adulthood, and is raised again in old age. Root has reported the results of these early studies of pitch.[1]

Experimental or Laboratory Research

Pitch production.-- Vocalized sound is the result of breath escaping through the speech mechanism. Pronovost gives the following explanation:

> Phonation is the production of sound by the vocal cords, which are folds of muscle tissue located in the larynx, During phonation the vocal cords are moved together, and the pressure of air from the lungs sets them vibrating....
>
> ....
>
> Muscles within the larynx move the vocal cords together so that the inner edges touch each other. The elastic nature of the vocal cords permits them to vibrate as the air is exhaled under pressure. Muscular action also controls the position and tension of the cords, which, in turn, influence the pitch, intensity, and quality of the voice. The pitch of the voice is determined primarily by the length, mass, and tension of the vocal cords.... Changes in muscular tension produce voice inflection and pitch variation.[2]

Steinberg used high-speed photography to reveal vibrations of the vocal cords during phonation. While producing lower pitches, the cords appeared to be completely relaxed. The pitch rose as tension increased and cords tended to elongate and move more as units with somewhat smaller amplitude than for low pitches. The analysis of the vocal cord

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[1]Alfred R. Root, "The Pitch Factor in Speech, A Survey," Quarterly Journal of Speech, XVI (June, 1930), 320-27.

[2]Dorothy Mulgrave, Wilbur Gilman, and Wilbert Pronovost, Speech, A Handbook of Voice Training, Diction, and Public Speaking, pp. 148-50. New York: Barnes and Noble, Inc., 1954.

vibrations indicated a vibration form composed of a fundamental having a frequency equal to the vibration rate of the cords and overtones, which diminish in amplitude with increasing order or number of the overtone.[3]

Average pitch.-- In research studies of voice functions, pitch is measured in terms of frequency of vibration and is reported both as cycles per second and as tones in a musical scale. To study pitch and duration characteristics of six superior male speakers, Snidecor used the phonophotographic technique originated by Metfessel, modified by Simon, and again by Lewis and Tiffin, and electrified by Cowan. This technique gives a photographic record of fundamental sound wave frequencies. Approximately 24,000 sound waves were considered by Snidecor. The median voice pitch of six superior male speakers was 17.30 tones above the zero reference frequency of 16.35 cps proposed by Fletcher.[4] The median reading pitch of the same group was about C_3, an octave lower than Middle C and 18.00 tones above the zero reference. The median reading pitch was .70 tones higher than the median speaking pitch.[5] In a companion study Snidecor obtained evidence of pitch and duration characteristics of six superior female speakers who read a 55-word passage under experimental conditions. He found that the mean pitch levels

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[3] John Steinberg, "High-speed Photography to Reveal Vibrations of Cords During Phonation," Journal of the Acoustical Society of America, XI (January, 1940), 373.

[4] Harvey Fletcher, "The Pitch, Loudness, and Quality of Musical Tones," American Journal of Physics, XIV (July-August, 1946), 215-25.

[5] John Snidecor, "A Comparative Study of the Pitch and Duration Characteristics of Impromptu Speaking and Oral Reading," Speech Monographs, X (1943), 51-52.

ranged between 21.32 and 22.80 tones above the zero reference frequency. The median reading pitch level for the female voices was 3.95 tones higher than the median reading pitch level for men's voices. Approximately four tones, or about two thirds of an octave, lay between the voices of men and women, in contrast to the generally assumed difference of one octave.[6] Cowan, using his electrified modification of the Metfessel technique, made a study designed to show pitch and intensity factors in relation to time in continued speech. The study entailed extensive analysis of some 20,000 speech sound waves in dramatic passages interpreted by ten actors and actresses. The average male pitch level was 141.0 cps, and the average female pitch level was 233.0 cps. Cowan found close correspondence between mean pitch levels and median pitch levels, the difference being .28 semitones. In close agreement with Snidecor's study, Cowan reported that the average level for women's voices was only nine semitones or three fourths of an octave above the men's average pitch. Within each sex group the superior male and female speakers used median pitch levels within one and one half tones of each other, which suggests that preferred pitch levels for superior speakers may fall within relatively narrow limits.[7]

Murray and Tiffin conducted an investigation to determine, in objective terms, the basic sound wave differences which distinguish the

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[6] John Snidecor, "Pitch and Duration Characteristics of Superior Female Speakers During Oral Reading," Journal of Speech and Hearing Disorders, XVI (March, 1951), 45-46.

[7] Cowan, *op. cit.*, pp. 80-81.

various types of speakers. Using a modification of the Metfessel phonophotograph, Murray and Tiffin obtained reading samples of 46 good voices, 88 poor voices, and 21 trained voices. Three pitch measures were made on 20 syllables of the spoken material for each subject. They observed that there were no significant differences between the average pitch levels of good, poor, and trained voices. However, there appeared to be a tendency for a larger proportion of voice deficiencies to appear when the average pitch was extremely high or extremely low. Regardless of this trend, both good and poor voices were found at these extremes. The data seem to warrant that average pitch level, considered alone, is a rather insignificant determiner of vocal effectiveness. Unusually high voices among the men were rated poor, while unusually low voices among the women were rated good. Fifty per cent of the pitches used by women were lower than the highest pitches used by men. Murray and Tiffin found no significant difference in the average pitch level used by speakers who differed widely in merit and experience. They concluded that a voice is not seriously handicapped by being relatively high-pitched if it is not deficient in some other respect.[8]

These conclusions were verified by Lewis and Tiffin in a study of individual differences in speaking ability. They tried by application of the law of comparative judgment to determine the rank order and scale value of six male voices on the basis of their use of pitch and other speech elements. After experienced speech professionals and college

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[8]Elwood Murray and Joseph Tiffin, "An Analysis of Some Basic Aspects of Effective Speech," Archives of Speech, I (January, 1934), 62-70.

sophomores had rated the six voices, which had been selected carefully to give a wide range of speaking ability, the Metfessel phonophotographic technique, modified by Lewis and Tiffin, was used to get exact and extensive physical measurements of sound waves from the voice samples. A voice key was computed for each voice. The fact that the voice which rated the highest in both general effectiveness and use of pitch variations also had the highest average pitch level, would seem to indicate that a high pitch level is not so serious a handicap as is usually supposed.[9]

To find a method for determining natural pitch, Pronovost studied the speech sound waves of six male college students, all of whom presented superior voice usage and articulation in reading and speaking. The median pitch level of this group of superior voices was 132.1 cps, or C below Middle C. Pronovost found that the median pitch lay about 25 per cent up the total range of pitch. He concluded that it is probable that both the individual's natural pitch level, that which is optimum or best for the individual, and the preferred pitch level, that which is used most frequently, should be considered in voice retraining. The study suggests that the recommended pitch level might lie between habitual pitch and natural pitch, the specific pitch to be determined by experimentation.[10]

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[9]Donald Lewis and Joseph Tiffin, "A Psychophysical Study of Individual Differences in Speaking Ability," Archives of Speech, I (January, 1934), 44-52.

[10]Wilbert Pronovost, "An Experimental Study of Methods for Determining Natural and Habitual Pitch," Speech Monographs, Research Annual, IX (1942), 114-23.

Lynch attempted to discover, through the use of the modified Metfessel technique, the fundamental character of pitch and time in emotional and unemotional reading. The experimental population was composed of a group of 25 trained readers and another group of 25 college freshmen with no experience in reading orally or acting. Factual material and emotionally charged material dealing with fear and grief were read by both groups while voices were recorded. Analysis showed that the average reading pitch for both male and female for emotional material was above that for factual material. The conclusion was reached that one of the most marked characteristics of expression of emotion is rise in pitch. Subjects in the same experiment were requested to raise or lower the pitch to characterize a male or female. In no case was the male or female character gained by raising or lowering the normal pitch level. From this evidence Lynch concluded that there is no justification for setting up one oral interpretation as a model. Instead, she suggested that certain broad principles should guide the reader to develop his own powers using his normal pitch.[11]

Fairbanks and Pronovost maintained that the most significant voice difference among emotions pertains to pitch and that many emotions can be identified by pitch alone. The conclusions were drawn from a study of the vocal portrayal of the unpleasant emotions of contempt, anger, fear, grief, and indifference by six competent actors. Pitch levels in the neighborhood of C_2 were employed for simulations of

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[11]Gladys E. Lynch, "Phonophotographic Study of Trained and Untrained Voices Reading Factual and Dramatic Material," _Archives of Speech_, I (January, 1934), 9-25.

contempt, grief, and indifference; while fear and anger were found approximately one octave higher. Fear had the highest median pitch level, 254.4 cps, while indifference had the lowest, 108.3 cps; the exact difference between the medians was 7.4 tones.[12] The findings of Fairbanks and Pronovost agree comparatively with those of Lynch, who having studied anger, grief, and factual reading, reported that the pitch levels of the three ranked in that descending order.[13] A conclusion drawn by Ortleb from a phonophotographic analysis of 40 syllables read by each of 15 speech-trained subjects, was that for both factual and dramatic material the emphasized syllables have a higher pitch than the unemphasized ones.[14]

The assertion that pitch rises when the voice becomes louder was substantiated by Skinner's experiment with nine men and ten women who were all well-trained in speech and acting. Loud, soft, happy, and sad tones were called for and recorded so various measures could be computed. The average frequency for soft tones for nine male voices was 120.0 cps and for loud tones, 172.22 cps, an average rise of 52.22 cps. The average frequency used by the ten female subjects for soft tones was 238.3 cps and for loud tones, 283.2 cps, an average rise of 44.9 cps. The reliability of these differences was 1000 and .965, respectively.[15] Skinner also observed that the vocal responses accompanying reactions to

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[12] Fairbanks and Pronovost, _op. cit_., p. 94.

[13] Lynch, _op. cit_., p. 18.

[14] Ruth Ortleb, "An Objective Study of Emphasis in Oral Reading of Emotional and Unemotional Material," _Speech Monographs_, IV (1937), 65.

[15] Skinner, _op. cit_., pp. 94-108.

happy stimuli were an average of 27.78 cps higher for males and an average of 64.50 cps higher for females than the average frequencies of ordinary tones used by these two groups.[16]

Brackett, too, found that pitch level tended to rise during loud speech. Twenty-seven male subjects were instructed to maintain their voices at specific loudness levels characterized as soft conversational, conversational appropriate for telephone communication in a large aircraft, and shouting. Every subject raised his pitch while increasing loudness. There was no correlation between pitch and intelligibility. In another phase of the same study 12 subjects in a normal, quiet environment spoke with an average frequency of 154.9 cps, whereas in noisy surroundings the same men spoke with an average frequency of 171.1 cps, showing a difference in pitch of 16.2 cps.[17]

Burke studied the pitch levels used by 29 fourth-grade children. He obtained seven recorded samples of each child's voice activities, including spontaneous conversation; easy, average, and difficult reading; and recall of each reading selection. Five syllables were selected from each of the seven samples. These syllables were subjected to the judgments of three people known to have high degrees of relative pitch. Each judge was permitted to make a naive report of his system for determining the vocal pitch. The judges showed a correlation of .99 for group judgment and the relatively low correlation of .72 for both individual judgments and later re-identification of pitch. Burke used subjective

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[16] Skinner, op. cit., p. 104.

[17] I. C. Brackett, "Intelligibility Related to Pitch," Speech Monographs, XIII (1946), 24-31.

analysis of voice pitch despite the instability of the judgments, because phonophotographic and stroboscopic apparatus were not available for the work. Burke agreed with Root that judgments of a trained observer are sufficient for identification of average pitch level but inferior to mechanical means.

Data were presented to show that when the reading pitch heightened because of the difficulty of the material, the speaking voice also raised. There seemed to be transfer of the difficult reading pitch to the recall pitch. There was further evidence from the study that the high pitch utilized for the difficult paragraph was transferred immediately to the easy paragraph. Poor readers showed a greater gain in pitch than good readers. Burke concluded that heightened pitch accompanies difficult reading. Once a pitch was raised above its normal level, it tended to remain there until the task was changed or the subject was reassured that easy material was to follow. Overall pitch variation was no greater for boys than for girls. Most oral reading utilized a pitch level above that of conversation. The author refrained from sweeping generalizations on exact pitch levels because of the very high and very low correlations obtained on the pitch judgments of the three experts.[18]

In a diagnostic study of reading difficulties in which Durrell's "Check List of Reading Difficulties"[19] was used to disclose the frequency

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[18]Harold L. Burke, "A Study in the Pitch of Oral Reading of Fourth Grade Children," pp. 15-70. Unpublished Master's thesis, School of Education, Boston University, 1939.

[19]Donald D. Durrell, "Durrell Check List of Reading Difficulties," Durrell Analysis of Reading Difficulty. Yonkers, New York: World Book Company, 1937.

and types of errors being made, Duffy reported that 24 per cent of 83 third-grade pupils used a high-pitched voice. A high-pitched reading voice was more prevalent among children in the upper intelligence quartile than among those in the lower quartile. Monotonous tone was used by 11 children in the lower intelligence quartile as compared to 5 children in the upper quartile.[20] A study by Barry and others showed that low pitch ranked tenth in frequency of 28 "errors" made in oral reading by a group of 100 fifth-grade pupils. High pitch with a ranking of 23 was among the ten least frequent "errors" in easy and difficult reading. The judgments of pitch in both Barry's and Duffy's studies were made by ear.[21]

Fairbanks, Herbert, and Hammond made intercomparisons of pitch levels and other pitch phenomena in the reading voices of 15 seven-year-old girls and 15 eight-year-old girls chosen from the population of the second and third grades in three elementary schools. A test passage of 52 words from the center of a reading selection was subjected to phonophotography. Pitch curves were plotted and frequency measurements made. The mean pitch levels reported were 281.0 cps for the seven-year-old females and 288.0 cps for the eight-year-old females. These measurements also were given as approximately one semitone above C_4 or Middle C. The pitch levels are similar to those of boys their own ages and boys up to

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[20]Gertrude B. Duffy, "A Diagnostic Study of Reading Difficulties in a Third Grade," p. 29. Unpublished Master's thesis, School of Education, Boston University, 1939.

[21]Edward Barry and others, "An Analysis of Voice and Language Characteristics in an Oral Recall Situation," p. 48. Unpublished Master's thesis, School of Education, Boston University, 1952.

the age of 14. The pitch levels for seven- and eight-year-old girls are 24.6 tones and 24.8 tones, respectively, above the zero reference of 16.35 cps and approximately one octave higher than the median pitch of the adult male.[22] In a companion study of boys' pitch, which was identical in experimental design to that of the girls' pitch of voice investigation reported above, Fairbanks, Wiley, and Lassman showed that the mean pitch levels for the seven- and eight-year-old males were 294.0 cps and 297.0 cps, respectively. These measurements also were presented as D, one tone above Middle C, and as 25.0 and 25.1 tones above the zero reference.[23]

Curry used phonophotography to obtain careful wave-to-wave measurements of the reading voices of six fourth-grade 10-year-old males, six adolescent 14-year-old males, and six postadolescent 18-year-old male college freshmen. The median pitch level for the 10-year-old males was 269.7 cps, or 24.4 tones above the zero reference 16.35 cps, and near C$^{\#}$ above Middle C. This value was approximately one semitone lower than the mean pitch found by Fairbanks and others for eight-year-old males. Fourteen-year-old boys had a median pitch of 23.4 tones above the zero reference and a corresponding frequency of 241.5 cps, which is slightly lower than B below Middle C. Means of boys seven, eight, ten, and fourteen and girls seven and eight are all within a 1.7 tone range and

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[22] Grant Fairbanks, Esther Herbert, and J. Marian Hammond, "An Acoustical Study of Vocal Pitch in Seven- and Eight-Year-Old Girls," Child Development, XX (June, 1949), 71-73.

[23] Grant Fairbanks, John H. Wiley, and Frank M. Lassman, "An Acoustical Study of Vocal Pitch in Seven- and Eight-Year-Old Boys," Child Development, XX (June, 1949), 65-69.

approximate Middle C (24.0 tones above 16.35 cps). The median pitch of the 18-year-old males was 137.1 cps, 18.42 tones above the zero reference, and near C# below Middle C. The median pitch levels of the 10- and 14-year-old groups approached each other around C_4 or Middle C, while the 18-year-olds were near C_3 or C below Middle C. A marked drop of approximately five tones in pitch occurred during the four-year period between the ages of 14 and 18. The 10- and 14-year-old males had median pitch levels close to the values reported for adult females. The data indicate that the major shift in the male voice is after the fourteenth year.[24]

Pedrey set about to study the relationship of pitch level to age and pubic development of 1,014 boys between the ages of 11 and 16. Data on the extent of pitch change were gained by listening to oral reading. It was noted that 75.5 per cent of the prepubescent boys were in the period of voice change. The greatest pitch shift in the direction of adult voice apparently occurs mainly after the age of 14, as there were only 3.72 per cent of the 13-year-old males and 20.17 per cent of the 14-year-old males with mature voices. Pedrey concluded that age and pubic development are about equally reliable as indices of the stage of development, the respective correlations being .65 and .68.[25]

Pitch range.-- In an investigation of vocal pitch described earlier in this study, Snidecor reported the total range representing

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[24] E. Thayer Curry, "Pitch Characteristics of the Adolescent Male Voice," Speech Monographs, Research Annual, VII (1940), 48-52.

[25] Charles P. Pedrey, "A Study in Voice Change in Boys between the Ages of Eleven and Sixteen," Speech Monographs, Research Annual, XII (1945), 35.

100 per cent measures of the combined pitches used by six superior male speakers as 8.42 tones for impromptu speaking and 9.89 tones for reading. However, Snidecor preferred to report pitch range obtained from phono-photographic analysis of the median 90 per cent of the combined pitches used by the six male voices. The value of this "mean functional pitch range" is seen in the fact that the median 90 per cent of the cases in reading was 5.19 tones, whereas the total range was 9.89 tones, an increase of 4.70 tones when only 10 per cent more of the highest and lowest tones were added.[26] In a companion study of superior women's voices Snidecor found that in all cases the median percentages of women's pitch range were smaller than men's. The difference in the number of tones used by the men became progressively greater up to the 90 per cent range, for which there was a difference of 1.25 tones. The 100 per cent range showed 10.52 tones for the men and 10.46 tones for the women, a difference of only .06 tones in favor of men's pitch range. Both men and women used speaking pitches below their singing pitches.[27]

Lewis and Tiffin reported pitch ranges of 3.8 tones to 9.9 tones among six male subjects who, because of wide differences in speaking ability, were selected for a psychophysical study of voice usage.[28] Murray and Tiffin, from research on basic aspects of effective speech described in the foregoing section of this chapter, defined total pitch

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[26] Snidecor, "A Comparative Study of the Pitch and Duration Characteristics of Impromptu Speaking and Oral Reading," op. cit., pp. 52-53.

[27] Snidecor, "Pitch and Duration Characteristics of Superior Female Speakers during Oral Reading," op. cit., pp. 48-51.

[28] Lewis and Tiffin, op. cit., p. 49.

range as the musical steps between the highest pitch reached at least twice and the lowest pitch reached at least twice. They felt that a more reliable measure of fundamental pitch range would result from taking points reached twice as the limits rather than points reached only once. They found from analyzing the reading voices of 45 good voices, 88 poor voices, and 21 trained voices, that the spread of men's voices was nearly twice as great as that of women. Relatively speaking, the trained voices had 58 per cent greater pitch range than the poor voices and 39 per cent greater range than the good voices. Good voices with narrow range seemed to be compensated by unusual flexibility in other vocal factors. Pitch ranges of 2.9, 4.5, and 6.3 tones for poor, good, and trained speakers were found by Murray and Tiffin.[29] Ranges of 5.8 and 8.2 tones for untrained and trained readers were noted by Lynch in a study previously referred to in this review of research.[30]

Skinner found from a phonophotographic study of vocal tones used during emotional speech that a group of nine adult males used, on the average, a slightly greater pitch span than ten female subjects in the same study.[31] A pitch range of about one octave for gifted speakers reading factual material was reported by Cowan. The phonophotographic analysis of the voices of the same speakers reading dramatic material disclosed an average extent of pitch range slightly in excess of two full octaves for males and slightly short of this value for females, the exact

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[29]Murray and Tiffin, op. cit., p. 72.

[30]Lynch, op. cit., p. 19.

[31]Skinner, op. cit., p. 109.

spread being from 1.28 octaves to 2.56 octaves.[32] Pronovost observed that five out of six actors in a study of the pitch aspects of emotional speech used about three octaves. Fear, anger, and contempt all had wide pitch ranges, while grief and indifference had the narrowest ranges.[33] The findings concerning fear and grief corroborate the work of Lynch done several years earlier.[34]

Fairbanks, Wiley, and Lassman reported a 100 per cent pitch range of 9.8 tones and a mean 90 per cent range of 3.6 tones for a group of 15 seven-year-old boys reading factual material. The eight-year-old males in the same study used a 100 per cent range of 9.7 tones with 3.9 tones lying in the mean 90 per cent range.[35] The companion study of seven- and eight-year-old female voices carried out by Fairbanks, Herbert, and Hammond gave 10.3 tones and 10.0 tones, respectively, in the 100 per cent range with 3.7 tones and 3.3 tones falling within the mean 90 per cent ranges.[36]

Woolbert, reporting a study dealing with voice stimulations and audience behavior, found in the unanimous judgment of auditors that changes in pitch are always significant. In the opinion of the auditors, monotonous pitch was detrimental to intellectual effectiveness. Wide range of pitch was preferable to no pitch change for the purpose of

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[32]Cowan, op. cit., pp. 59-61.

[33]Fairbanks and Pronovost, op. cit., pp. 94-95.

[34]Lynch, op. cit., p. 18.

[35]Fairbanks, Wiley, and Lassman, op. cit., p. 68.

[36]Fairbanks, Herbert, and Hammond, op. cit., pp. 71-73.

securing audience retentiveness over an extended time.[37] Murray and Tiffin, while studying basic aspects of effective speech, recognized that narrow pitch range was generally associated with raucous, infantile, strident, hard, and harsh voices. Good voices with narrow pitch range seemed to be compensated by unusual flexibility in either the intensity or duration factors, or both.[38]

In general, the data from several studies seem to be in keeping with the point of view common among teachers of speech, that wide range ordinarily is characteristic of effective speaking. However, Lewis and Tiffin concluded that pitch range is for most purposes a very unreliable and inadequate measure of pitch usage, the reason given being that one extreme measure will increase the range out of all proportion to the actual functional dispersion. They believe pitch range has been a bit overemphasized. From a careful analysis of differences in speaking ability cited earlier, they drew what they claim is a reasonable conclusion: A very narrow range is poor, but after a certain easily attainable range is reached, further increase probably does not increase vocal effectiveness.[39]

Pitch variability.-- Pitch variability or flexibility is generally considered a significant pitch measure because it gives an indication of not only the pitch range, but also the relative amount of use

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[37] Charles H. Woolbert, "Effects of Various Modes of Public Reading," Journal of Applied Psychology, IV (June-September, 1920), 162.

[38] Murray and Tiffin, op. cit., p. 71.

[39] Lewis and Tiffin, op. cit., p. 52.

made of all the pitches through inflections, shifts, and breaks within the range. The significance of this concept was developed by Lewis and Tiffin after they concluded that range was an unreliable measure of pitch usage. As a means of clarifying this concept, they constructed frequency distributions of all pitches used by each of six male speakers for which they had listener judgments of rank order and scale value on the basis of their use of pitch and other vocal factors. The better speakers in this study did not always use the widest pitch range, but they did tend to use pitches falling within about an octave in a manner suggestive of a normal distribution. In the same study frequency distributions of pitch for the poorer voices revealed such things as one very high peak (monotonous pitch), a bimodal distribution (bipitch), and extension into pitches outside the mean 90 per cent pitch range.[40]

Cowan studied the variability factor through frequency distribution of all the pitches used by ten actors and actresses reading dramatic material. There was a pronounced tendency for the speakers to use pitches in a central portion of the range most frequently and those on either side of the middle of the range with gradually decreasing frequency as they are further removed from the average. The frequencies approximated a normal distribution.[41] Pronovost presented individual frequency distributions of the pitches used by each of six male college students reading the same passage as part of an experiment to locate natural and habitual pitch. Observation of the distributions showed that

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[40]Ibid., p. 51.

[41]Cowan, op. cit., p. 66.

each approximated the shape of a normal curve and that the median and mode coincided closely.[42]

Snidecor noted that in two studies involving superior male and female voices, the voices of the females were less variable than the male voices. The mean standard deviation of the distribution of speaking and reading pitches for women was 1.52 tones, or approximately one third of a tone less than the mean standard deviation of 1.89 tones for the distribution of pitches used by the males. When individual differences were considered, five of the six women evidenced lower values for the standard deviation of pitches than all but one male.[43] Lynch recognized the importance of pitch variability in a study she made of trained and untrained voices reading factual and dramatic material portraying anger and grief. It was her belief that a concept of variability based on the standard deviation of all pitches used was a more reliable and stable measure than pitch range. The trained readers used greater variation in pitch inflection on the anger selection, with a tendency to set off significant words by using large and more complex inflections, than the inexperienced readers.[44]

When studying pitch of voice used by six competent male actors in a portrayal of six unpleasant emotions, Fairbanks and Pronovost found downward inflections to be wider and greater in number than upward

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[42]Pronovost, op. cit., p. 116.

[43]Snidecor, "Pitch and Duration Characteristics of Superior Female Speakers during Oral Reading," op. cit., p. 48.

[44]Lynch, op. cit., p. 20.

inflections. Within phrases, upward shifts were found to be greater and wider than downward shifts for all emotions studied except indifference, where the extents were found to be equal.[45]

Fairbanks, Wiley, and Lassman, studying the pitch characteristics of seven- and eight-year-old males, found that monotonous pitch was perceptible by comparing the 90 per cent range (the range between the 95th and 5th percentiles of the frequency distribution of pitches used) with 100 per cent range. The total range for seven-year-old boys was 9.8 tones, with 3.6 of these accounted for in the 90 per cent range. The standard deviation was 3.3 for the total range and .9 for the 90 per cent range. For the eight-year-old boys the 100 per cent range was 9.7 tones, with 3.9 lying in the 90 per cent range. The standard deviations were 4.0 and 1.4, respectively. Fairbanks conjectured that this reduced variability was not characteristic of speaking voices of children but may well be typical of their oral reading during the early grades. The data showed no significant differences between the two age levels sampled.[46] Similar results were shown concerning the voices of seven- and eight-year-old females. The total range of pitch was 10.3 tones and 10.0 tones with a standard deviation of 1.2 and 2.3, respectively. A 90 per cent range of 3.7 and 3.3 tones, with standard deviations of .7 and 1.1 for the seven- and eight-year-old girls, indicated the same monotony of pitch that was reported in the companion study of male voices. Again, no significant differences occurred between the two age groups.[47] According

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[45]Fairbanks and Pronovost, op. cit., p. 104.

[46]Fairbanks, Wiley, and Lassman, op. cit., p. 67.

[47]Fairbanks, Herbert, and Hammond, op. cit., p. 73.

to E. Thayer Curry, 10-year-old boys reading factual material had less variability in pitch usage than either the 14- or 18-year-old males. Their total pitch range was 9.89 tones, yet 3.16 tones contained 90 per cent of the pitches used. The 90 per cent ranges for the 14- and 18-year-old males were 5.23 tones and 6.18 tones, respectively. The older groups also had slightly greater change in direction of pitch movement during phonation.[48]

Research conducted by McIntosh was designed to show the relationship between pitch level and pitch variability in the voices of superior speakers. Under experimental direction, the superior speakers were asked to speak with higher and lower than normal pitches and with more variability and less variability than the normal speaking voice. Data were presented to show that increase or decrease in variability tended to be accompanied by systematic change in pitch level. In general, high-pitched readings resulted in increased variability, while lower-pitched readings evinced the opposite tendency. Both McIntosh and Snidecor agreed that the nature of the performance must be considered when interpreting differences in pitch variability.[49]

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[48]Curry, op. cit., pp. 53-54.

[49]C. W. McIntosh, Jr., "A Study of the Relationship between Pitch Level and Pitch Variability in Voices of Superior Speakers." Unpublished Doctor's dissertation, State University of Iowa, 1939, cited by Grant Fairbanks in "Recent Experimental Investigations of Vocal Pitch in Speech," Journal of the Acoustical Society of America, XI (April, 1940), 461-62.

Techniques for Objective Studies of Vocal Pitch

Because the phenomena of acoustics are all too minute and too rapid to be dealt with directly, it is necessary to study sound with the aid of devices which faithfully record and realistically reproduce the original sound.

Sound recording.-- By the beginning of the twentieth century the phonograph was established as a recording and playback device. About this time new reasoning was being applied to the development of sound recording apparatus: It might be possible to magnetize a wire to different degrees so close together that sound could be recorded on it by running the current from a microphone through an electromagnet or drawing the electromagnet rapidly past the wire. The device which resulted from this reasoning could play back the original message, but the playback level was very low. Magnetic recording had to await the development of amplifiers before it could be used widely.

Sound was first recorded for the movies on synchronized steel tape. A later design, using Vicalloy,[50] permitted the use of magnetic powder-coated steel tapes. This was superseded by a thin stainless steel wire and, more recently, by a metallized plastic tape.

Modern sound recording is explained in the following terms in a tape recorder manual:

> In tape recording, sounds are transformed into varying electrical impulses which activate a magnet in contact with the metallized side of the tape, magnetizing the tape in sound patterns. When the tape is played back, these invisible patterns are changed back into

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[50] Begun, op. cit., p. 95.

electrical impulses, amplified, and passed through a loud speaker. The result is a faithful reproduction of the original sound.[51]

Emmett Betts, realizing the problem involved in the study of language activities, undertook an appraisal of five techniques for collecting oral English, including electric recording, court reporting, shorthand reporting, longhand reporting, and phonetic analysis. The electrical recording produced records of 40,214 words of oral composition with 99.7 per cent accuracy as compared to all other types of reporting, for which the accuracy percentages, based on the same number of words, ranged from 14.9 per cent to 80.4 per cent. The study definitely established that electrical recording is a tool for research in oral English.[52]

Visible speech.-- A manometric apparatus for analyzing pitch by means of variations in a flame, produced by vibrations of air acting on a capsule controlling the gas supply, was used by early researchers in studying pitch of the voice.

Dayton C. Miller invented a means of photographing sound waves which he named the phonodeik. The simplified form of this machine consisted of a tiny iron fork which was attached to the center of a diaphragm with its prongs resting on the pole-tips of a permanent magnet. A tiny mirror was fastened to this wire. When the diaphragm vibrated, the prongs of the fork rolled the wire slightly on the poles of the magnet. This rocking motion of the mirror caused the beam of light to swing

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[51] Manual of Operating Instructions for the Pentron Multi-Speed Tape Recorder, Model 9T-3C, p. inside front cover. Chicago: The Pentron Corporation, 1953.

[52] Emmett A. Betts, "An Experimental Appraisal of Certain Techniques for the Study of Oral Language Activities," Education, LVI (January, 1936), 301-04.

up and down. By throwing this beam on a mirror which rotated rapidly on a vertical axis, a curve which was characteristic of sound waves was thrown on a screen. Miller introduced a base line of known frequency in phonophotography so that pitch in time could be read.[53]

Visible speech also was developed by Seashore. His device, the tonoscope, worked on the principle of moving pictures, technically known as stroboscopic vision.[54] The tonoscope produced for the eye a picture of the vibrations of a tone which revealed details of pitch accurately and far more finely than the ear could hear, thus affording a most sensitive objective pitch measurement. The pitch was read by direct inspection while the speaking, singing, or playing was in progress. The pitch indication was not, however, in the form of a continuous curve, as the semitone was divided into five parts. Further work was necessary to show pitch in time in the form of a continuous curve.[55]

Merry studied vocal inflection through the use of the disc-lever recorder, the cylinder-lever recorder, and the phonograph recorder with the tonoscope. He preferred the latter for voice study.[56] Kwalwasser continued experimentation with the Seashore tonoscope and Merry's disc-

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[53]Dayton C. Miller, Science of Musical Sounds, pp. 78-83. Boston: The Macmillan Company, 1916.

[54]For description of stroboscopic vision see: James M. Baldwin (ed.), Dictionary of Philosophy and Psychology, Vol. I., p. 513. New York: Peter Smith, 1940 (new edition).

[55]Carl E. Seashore, The Tonoscope, University of Iowa Studies in Psychology, VI, pp. 1-12, cited by Max Schoen, "An Experimental Study of the Pitch Factor in Artistic Singing," Psychological Monographs, XXXI (1922), 231.

[56]Glenn N. Merry, "Voice Inflection in Speech," Psychological Monographs, XXXI (1922), 205-14.

lever recorder, and concluded with a device for photographing sound waves which utilized a motion picture camera, two phonelescopes, and a timing mechanism. With this, pitch fluctuations, pitch intensity relationship in crescendo, and other measurements were made.[57] Simon made the first basic study with regard to wave-to-wave pitch fluctuations of the human voice. He made use of Seashore's tonoscope as a means of constant passage of film for photography with the phonelescopes. He concluded that the wave-length method can be used if the disideratum is information concerning individual wave-to-wave fluctuations in pitch.[58]

Metfessel's new and adapted phonophotographic apparatus was constructed to unite all the advantages of the apparatus used by former workers in the field. Essentially, the main parts of his phonophotographic apparatus were (a) a large drum about which a standard motion picture film winds after (b) photographing the lights reflected in vibratory motion from two phonelescopes, the one a graphic representation of sound waves from a known source of 100 cps electrically driven tuning fork, referred to as the time-line.[59] The phonophotographic technique developed by Metfessel and improved by Simon, Lewis and Tiffin, and electrified by Cowan, was used by Snidecor, Lynch, Curry, and others to

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[57] J. Kwalwasser, "An Experimental Study of Pitch, Time, Tone, and Intensity Factors in the Dynamics of Vocalization." Unpublished Doctor's dissertation, University of Iowa, 1923, cited by Milton Metfessel, "Techniques for Objective Studies of the Vocal Art," Psychological Monographs, XXXVI (1927), 2.

[58] Clarence Simon, "The Variability of Consecutive Wave-Lengths in Vocal and Instrumental Sounds," Psychological Monographs, XXXVI (1927), 61.

[59] Metfessel, *op. cit.*, pp. 1-26.

study pitch and duration factors of speech. The device permitted the measurement of fundamental sound wave frequencies from phonographic recordings by phonophotographic means. It was customary to make average measurements over consecutive intervals of .038 seconds each. The overall error of this method of frequency measurement was negligible, being in the order of .5 per cent or .04 tones.[60]

Railsbeck described a chromatic stroboscope for piano tuning which included three features that he maintained any pitch-measuring device should have, namely, (1) it must be direct reading, (2) the error in measurement must be smaller than the human ear can detect, and (3) it must function for all frequencies within range of the investigation.[61] A frequency meter suitable for high speed recording was developed by Hunt. It was direct reading, gave a quick response to the speech signal, was easily calibrated, and had a wide range within which the frequency indications were independent of amplitude or wave form. This pitch meter could be used to teach proper intonation to the deaf and as a general purpose indication frequency meter for the laboratory.[62] Obata and Kabayashi devised an electrical arrangement by which rapid variations in pitch with time, such as occur in speech, could be recorded directly even in detail. The arrangement consisted of amplifiers, a wave form adjustor,

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[60] Fairbanks, "Recent Experimental Investigations of Vocal Pitch in Speech," Journal of the Acoustical Society of America, XI (April, 1940), 457.

[61] D. L. Railsbeck, "Chromatic Stroboscope," Journal of the Acoustical Society of America, IX (July, 1937), 37.

[62] Frederick V. Hunt, "A Direct Reading Frequency Meter Suitable for High Speed Recording," Review of Scientific Instruments, VI (February, 1935), 43-46.

an automatic volume control, and a frequency meter.[63] The latter was the same as the two-tube thyratron inverter which was developed by Hill and modified by Hunt. This machine was revised the following year by the inventors.[64] Dempsey reported that neither machine was entirely satisfactory without giving reasons for this conclusion.[65]

Gruenz and Schott improved the method of extracting pitch information. Their pitch meter employed a gain control, voiced sound selection, unvoiced sound exclusion, and a means of counting fundamental vibrations. The machine worked over a range of 100 to 600 cycles. In this machine two portrayals of pitch were used, the first a colored light display and the other, a graphical portrayal on an oscillograph. For color there were 18 lamps from purple for low pitch up to blue for high pitch. Several gas tubes, operated on pitch indicating voltage from the pitch signal amplifier, were set to fire at predetermined levels. The hardest part in developing the machine was that of obtaining usable indicating signals which must be extracted from a great variety of complex waves that were applied from the original speech sounds.[66]

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[63] Juichi Obata and Ryuji Kabayashi, "A Direct Reading Recorder and Its Application to Music and Speech," Journal of the Acoustical Society of America, IX (October, 1937), 156-57.

[64] Obata and Kabayashi, "An Apparatus for Direct Reading of the Pitch and Intensity of Sound," Journal of the Acoustical Society of America, X (October, 1938), 147-49.

[65] M. E. Dempsey, G. L. Draegert, R. P. Siskind, and M. D. Steer, "Purdue Pitch Meter--A Direct Reading Fundamental Frequency Analyzer," Journal of Speech and Hearing Disorders, XV (June, 1950), 135.

[66] O. O. Gruenz, Jr., and L. O. Schott, "Extraction and Portrayal of Pitch of Speech Sounds," Journal of the Acoustical Society of America, XXI (September, 1949), 487-95.

Several pitch-measuring devices currently are being used in scientific experimentation. Among the recent inventions are the cathode-ray oscilloscope, which produces visual indication of the wave form composition of speech sounds. Pronovost reported that the machine has limited usefulness as a pitch indicator, since it has been found adaptable only to voice cases requiring a change of pitch level in excess of half an octave.[67]

The linguascope, developed and reported by Friedrich Vilbig, photographically transposes speech, originally recorded on a 35 mm film sound track, onto a second film, allowing simultaneous visual analysis and selection of arbitrary track segments. The second film is developed and played back on sound film apparatus. It serves to investigate, among other things, frequency bands used in speaking.[68]

In the case of speech training of the severely deafened, Potter states that it is essential to show the pitch used in speaking. For this reason, attempts are being made to display pitch by varying the position of a moving trace and by varying the brightness of a line of light in the spectrograph representation. A satisfactory solution is not yet available, but the indications are that a practical solution is possible.[69] Pitch may be displayed in two ways, one as an integral part of the speech

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[67]Pronovost, "Visual Aids to Speech Improvement," Journal of Speech Disorders, XII (1947), 388.

[68]Friedrich Vilbig, "The Linguascope," Journal of the Acoustical Society of America, XXVI (January, 1954), 138.

[69]Ralph K. Potter, George A. Kopp, and Harriet C. Green, Visible Speech, pp. 20-21. New York: D. Van Nostrand Company, Inc., 1947.

pattern and the other by means of a separate display. According to Potter, much remains to be learned about the advantages and disadvantages of the integral type of pitch display.[70] Pitch frequencies may be placed on a logarithmic rather than on a linear scale. When a logarithmic or octave scale is employed, variation in pitch results in a rise or fall of the whole overtone group without changing the amount of separation between adjacent harmonics.[71]

Major mechanical and circuit design problems which are still unresolved in the development of speech display equipment were acknowledged in a summary of recent designs of the cathode-ray speech translator and continuous linear and logarithmic sound spectrographs. These difficulties explain why such an instrument as a practical logarithmic spectrograph has not as yet been constructed.[72]

An instantaneous pitch-period indicator based on the so-called "wave form approach" has been developed by Dolansky. In this approach consecutive sections of the speech wave form are compared to each other in order to establish the degree of variation between them. The pitch period is identified by a time reference point. This device performs this reference point identification automatically and almost instantaneously by generating a pulse derived from the wave itself and indicating the beginning of a new period as soon as possible. In spite of some

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[70] _Ibid_., pp. 294-95.

[71] _Ibid_., p. 303.

[72] Gordon E. Peterson, "Design of Visible Speech Devices," _Journal of the Acoustical Society of America_, XXVI (May, 1954), 413.

limitations, Dolansky asserts that the pitch-period indicator will give an indication of the beginning of each pitch period of any voiced sound, with a small delay and a high degree of reliability, thus making faster speech wave form studies possible.[73]

The Purdue pitch meter, used in the present study of vocal pitch, was developed from refinements of circuits of previously devised pitch-measuring instruments. Its operation consists of taking speech or other complex sounds from either a microphone or phonograph, amplifying them, selecting the fundamental or lowest frequency, and indicating that frequency on a meter scale calibrated in cycles per second. Any signal whose fundamental frequency is between 50 and 1000 cps, sinusoidal or complex, may be applied to the input. The lowest frequency component is amplified, while the higher harmonic components are effectively attenuated.

Three ranges are provided: 50-250, 100-500, and 200-1000 cps. The range selection switch selects the range of the meter and controls the degree of attenuation of the high frequency components. Within the instrument, the wave form is altered, but the frequency of the pulses entering the frequency portion of the circuit remains the same as the fundamental frequency of the applied signal. With the meter scale marked in cycles per second rather than in milliamperes, fundamental pitch is read directly in cycles per second. The fundamental frequency of the signal may be read directly from the recording meter, or it may be

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[73] Ladislav O. Dolansky, "Instantaneous Pitch-Period Indicator," Journal of the Acoustical Society of America, XXVII (January, 1955), 67-72.

presented as an audible tone by means of headphones or a loud-speaker. The audible tone representation carries no intelligence except pitch and pitch changes. There is no indication of articulation, voice quality, or changes in intensity.

Special features of the instrument are an optimum level volume indicator and a reference oscillator. Volume of the instrument is not critical except where the signal must be amplified above a threshold. Excess gain is undesirable only as extraneous room noises are amplified to trigger the frequency meter. The reference oscillator provides a "return" level for a recording instrument. The oscillator is a type of free-running multivibrator with frequency continuously variable from approximately 50-800 cps with a separate ON-OFF switch. When the oscillator is in operation and no other signal is applied to the instrument, the indicating meter or recorder indicates the oscillator frequency. As soon as a voice signal of adequate intensity enters the circuit, the fundamental frequency of the voice signal is indicated. Between voice signals, the indicator returns to the level of the oscillator frequency. This adjustable "return" or reference level increases the effective speed of response of the meter, since the meter movement need not start each swing at zero, but may begin each series of excursions at a point adjustably close to the maximum displacement. The oscillator may be employed also as a signal for calibration checks on the instrument. Accurate calibration of the instrument may be accomplished by using a standard tuning fork for a signal. Since the response of the circuit is linear over the total range, it is necessary to set only one point on one range to calibrate the instrument. The operation of the Purdue pitch meter is reduced to a set of simple steps which increase its value as a clinical or laboratory instrument.[74]

Summary

The foregoing review of research includes speculative and experimental studies of vocal pitch and the instruments through which the latter were accomplished. An examination of studies of the pitch of children's voices reveals that:

1. A variety of methods has been used to gather pitch of voice samples.
2. With minor variations, certain basic types of procedures have been used repeatedly to measure vocal pitch.
3. There is no comparative study of children's speaking and reading pitches involving the use of a pitch meter for extracting fundamental frequency of the voice.
4. No statistically significant results are reported concerning average pitch levels used by children for speaking, reading, and recall of reading.
5. With one exception, the number of children's voices studied under one procedure in any one investigation does not exceed 30.

It was with the realization that pitches of children's voices during various oral tasks are largely unidentified that this study was attempted.

[74] M. E. Dempsey, and others, op. cit., pp. 135-41.

CHAPTER III

PLAN OF THE STUDY

Outline of Procedures

The purpose of this study was to find out what a child does with his vocal pitch when he speaks, reads, and recalls what he has read. Average pitch levels for children in grades two, four, and six were identified from fundamental frequencies extracted by the Purdue pitch meter Briefly, the research procedures included: (1) selection of the population and collection of pupil data; (2) selection of situations for stimulating speaking, reading, and recall of reading; (3) preparation of tape recordings of children's voices and (4) pitch meter analysis of the recorded voices. The latter will be described in Chapter IV.

Population of the Study

Criteria for selecting the population.-- The criteria used to select the population for this study are:

1. The population should represent the total independent reading range of the elementary pupils in grades one through six.
2. The pupils should represent normal ranges of socio-economic background, intelligence, and school achievement.
3. The pupils should be readily available for voice recording.

These criteria were satisfied by using 188 children from grades two, four, and six in two schools in a small city about 20 miles from Boston.

According to the school authorities, the homes from which the children came ranged from "socially deprived" to "socially elite." Heterogeneous grouping was used in the schools. Of the 188 children whose voices were recorded originally, 28 were eliminated later because of extraneous noises in the transcriptions of their voices, incomplete personal data records, or inability to read independently, thus reducing the population to 160 children. Each child in the study was his own control.

Pupil data.-- Intelligence quotients were derived from the California Short Form Test of Mental Maturity[1] which was administered to the study population by the writer during the period from May 27 to June 4, 1954. The 1953 Primary Form for grade two was scored by hand by the writer; the 1950 Elementary Form for grades four and six was machine scored.

Educational achievement and reading achievement grade equivalents were obtained from scores yielded by the Metropolitan Achievement Test,[2] Primary II Battery, Form T, for grade two Elementary Battery, Form T, for grade four; and Intermediate Partial Battery, Form T, for grade six. The educational achievement score was derived from tests of arithmetic, reading, spelling, and vocabulary. The reading score was based on tests of word meaning and reading comprehension contained in the achievement battery. These tests were given and scored by the classroom teachers

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[1] Elizabeth T. Sullivan, Willis W. Clark, and Ernest W. Tiegs, California Test of Mental Maturity (Los Angeles: California Test Bureau, 1953).

[2] Gertrude Hildreth and others, Metropolitan Achievement Tests (Yonkers, New York: World Book Company, 1947).

on May 11, 1954.

The test scores and other information concerning the performance and attitude of each child toward the oral tasks were placed on an individual pupil data sheet, a copy of which appears in Appendix A.

The tables below furnish a description of the population.

TABLE 1

SEX DISTRIBUTION OF PUPILS IN THE STUDY

	Grade 2	Grade 4	Grade 6	Total
Boys	29	31	33	93
Girls	22	21	24	67
Total	51	52	57	160

TABLE 2

CHRONOLOGICAL AGES OF PUPILS
(Reported in Months)

	Grade 2	Grade 4	Grade 6
Mean	93.627	119.942	141.842
S.D.	5.008	5.969	5.126

A mean chronological age of slightly under 8 years near the end of grade two, of 10 years near the end of grade four, and of not quite 12 near the end of grade six was normal. A standard deviation of less than a year was to be expected in a school system where annual social promotion prevailed.

TABLE 3

FREQUENCY DISTRIBUTION OF INTELLIGENCE QUOTIENTS

Range and Scores	Frequency Grade 2 N 51	Grade 4 N 52	Grade 6 N 57	Total N 160
145-149	1	0	0	1
140-144	0	1	0	1
135-139	5	1	0	6
130-134	4	4	2	10
125-129	4	1	9	14
120-124	9	2	5	16
115-119	6	3	10	19
110-114	8	6	9	23
105-109	4	1	5	10
100-104	6	6	5	17
95-99	2	5	6	13
90-94	1	11	2	14
85-89	1	6	1	8
80-84	0	4	2	6
75-79	0	1	1	2
Mean	116.980	102.635	111.175	110.250
S.D.	12.891	15.939	13.678	15.227
Range	88-147	78-143	75-131	75-147

The intelligence of the study population is shown in Table 3 to be within the normal range for the general school population. Mean intelligence quotients above 100 indicate that the groups were somewhat above average in intelligence.

TABLE 4

EDUCATIONAL ACHIEVEMENT SCORES OF PUPILS
(Metropolitan Achievement Test--Grade Equivalents)

	Grade 2	Grade 4	Grade 6
Mean	3.512	5.627	8.712
S.D.	.686	.918	1.331

The means of the scores indicate that the second-grade and fourth-grade pupils were slightly more than one half year above the average achievement for the grades, while the sixth grade was more than one and one half years above average in educational achievement in the areas tested.

TABLE 5

READING ACHIEVEMENT SCORES OF PUPILS
(Metropolitan Reading Achievement Test--Grade Equivalents)

	Grade 2	Grade 4	Grade 6
Mean	3.767	5.704	8.849
S.D.	.853	1.402	1.769

The reading achievement means for grades two and four were more than one half year but less than one year above the grade levels in the reading abilities tested by the Metropolitan Achievement Test. Grade six showed a mean reading achievement of nearly two years beyond the grade level in the abilities tested.

Selection of Materials for Tape Recordings

Materials were selected to stimulate children to perform five oral tasks in such a way that normal vocal pitch could be recorded for subsequent analysis and study. The tasks, speaking, easy reading, recall of easy reading, difficult reading, and recall of difficult reading, were adjusted to the child's interests and abilities with the aid of pictures and carefully graded reading paragraphs. These materials are described below.

Speaking.-- After it was decided to use pictures to start a child talking in a normal conversational voice, a preliminary study was carried on in a school not participating in the main study to find pictures which would actually motivate conversation easily. A group of 40 pictures from the vertical files of the Boston Public Library were thought to have high interest appeal for children in grades two, four, and six. These pictures were shown to each child in grades two, four, and six in the cooperating school. Each picture was classified as stimulating or nonstimulating according to the conversation which followed its presentation. More than two thirds of the pictures were eliminated because they either had no power to stimulate conversation or the appeal was limited to one age or sex group. Twelve pictures portraying baseball, basketball, boy scouting, a dentist, a doctor, dogs, fire fighting, figure skating, toys, and water skiing elicited oral responses from both boys and girls in the three grades and, therefore, were used in the main study. More specific techniques for using the pictures to obtain samples of conversation are discussed later in this chapter.

Oral reading.-- Two tasks, easy and difficult oral reading, were included in the plan of study to show a clear contrast of pitch usage if one existed. Easy reading refers to a level of difficulty one year below the instructional reading level.[3] The material presents no major difficulty to the reader. Difficult reading in this study refers to reading of materials one year or more above the instructional level which present either major difficulties or a definite challenge to the reader's abilities. The classroom teachers specified the instructional reading level for each child. The ten standardized paragraphs comprising the Gilmore Oral Reading Test, Form B,[4] were used to cover the easy and difficult reading range of the population of the study. The paragraphs were graded carefully with regard to vocabulary, sentence structure, and content. Each was long enough to permit adequate sampling of the reading voice. The paragraphs formed one continuous story which told different episodes in the life of a family group. The fact that each paragraph was a unified and self-sufficient narrative, related to the others only by its concern with the same characters, provided both unity and sequence for the discontinuous paragraphs each child was asked to read. The characters were portrayed in an illustration preceding the paragraphs to create interest and make the activity more like the normal reading of a book.

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[3] Instructional reading level is the term used to describe that range of difficulty in the gradation of reading material where the individual reads with at least fair comprehension, although he begins to average more than one major error in twenty running words, and/or his reading may start to be labored and slow.

[4] John V. Gilmore, Gilmore Oral Reading Test (Yonkers, New York: World Book Company, 1951).

Copies of both forms of the Gilmore Oral Reading Test appear in Appendix A.

Unaided oral recall of reading.-- Unaided oral recall of reading is a controlled form of speaking which is dependent upon the material read and the individual's word abilities, comprehension, organization, and memory. It was assumed for purposes of this study that oral recall is distinct from speaking and reading due to the higher order of skills involved and, therefore, the recall voice should be sampled apart from conversational speaking voice. No special materials were needed to stimulate unaided recall. Techniques for asking for recall are described later in this chapter.

Preparation of Tape Recordings of Children's Voices

Apparatus.-- A Pentron tape recorder,[5] Model 9T-3C, with standard microphone, foot pedal, and "Scotch" brand plastic sound recording tape,[6] Number 111A, were used. The pictures to stimulate conversation, the spiral bound book of Gilmore Oral Reading Test paragraphs, and the pupil data sheet, all previously described in this chapter, constituted the equipment used to obtain recorded samples of a child's voice during speaking, reading, and recall of reading.

Recording environment.-- In one school a teachers' lounge was made available for the work. In the other school the music room was used

[5]Manufactured by the Pentron Corporation, 221 East Cullerton, Chicago, Illinois.

[6]Manufactured by the Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.

in the morning, and the kindergarten room in the afternoon. Two chairs from the child's classroom faced a low table on which the microphone was placed about 15 inches away from the child's mouth. The child sat to the operator's left. The tape recorder was placed on another low table to the right of the operator, at right angles to the child's direct line of vision.

Recording procedures.-- The procedure described here was used to tape record the voices of 160 pupils participating in a study of vocal pitch during speaking, reading, and unaided recall of reading.

Every opportunity was used to talk with the children before school, at noon, at recess, and after school. Whenever possible, the writer joined in classroom activities, such as storytelling, listening to oral reports and oral reading, attending assembly programs, and watching play periods. Children were encouraged to see the room where the tape recorder was used. They carried the equipment to the room each day and helped set it up in operating position. This orientation had the desired effect of releasing anxiety, as indicated by the fact that only three out of 188 children asked at the time their voices were recorded, "What does this thing do?" These three were permitted to hear a brief playback of a classmate's voice, which was sufficient to satisfy their curiosity and gain their cooperation.

The writer called for each child at the door of his classroom and accompanied him to the recording room. Occasionally, conversation began en route and continued in the room after the recorder was engaged. This gave the necessary sample of normal conversation. More frequently, however, a child seated himself while the writer spread out the pictures on the table and encouraged the child to indicate some that interested him. For example, one child picked up the picture of a baseball game and said, "I play this all the time."

The writer asked, "When does your Little League team play its next game?" The conversation which followed consisted of the normal give and take of two people talking. The conversation flowed unrestrictedly from theme to theme until a tape recorded sample of about one minute had been taken. Whenever the writer spoke, the foot pedal was depressed to halt the machine. It was released the moment the child began to speak. In this manner, only the child's voice was on the tape. Insofar as possible, the writer made a controlled effort to speak with minimal animation when giving directions or conversing with the child during recording so that the child's voice would not reflect the pitch movements of the writer's voice.

After the conversational sample was acquired, the child's attention was directed to the picture of the family about which the Gilmore Oral Reading Test paragraphs were written. The child was asked to read a paragraph approximately one year below his instructional level. He was allowed about ten seconds to look over the material before he began to read aloud. When the child had finished reading, the writer said, "Please tell all you can remember about the story you've just read." The pupil was given unlimited time to think and recall. No questions were asked to encourage recall, since unaided recall was desired for pitch analysis. In cases where the writer had difficulty knowing whether a child had finished recalling or was just hesitating before going on, the writer asked, "Any more?" The question was asked just once during the recall of any one paragraph and then only for the reason mentioned above.

The unaided recall following easy reading is referred to in this study as recall of easy reading. Recordings of difficult reading and subsequent unaided recall of difficult reading were obtained by having the subject read a paragraph one year or more beyond his instructional level and then tell what he had read. In some instances, the difficult reading level was hard to locate because the child experienced no challenge from material as much as two years beyond the instructional level reported for him by his classroom teacher. In such cases, the writer experimented to find a challenging reading level by administering a brief, informal, on-the-spot oral reading test using the Gilmore Oral Reading Test paragraphs, Form A, a copy of which may be found in Appendix A. When a sufficiently difficult paragraph was located, the child's voice was recorded as he read a paragraph of equal difficulty from Form B of the Gilmore Oral Reading Test paragraphs.

The recording procedure described above netted five samples of a child's voice in the following order: (1) speaking, (2) easy reading, (3) recall of easy reading, (4) difficult reading, and (5) recall of difficult reading.

Notes on the child's attitudes toward the various tasks and other observable traits or irregularities during his speaking and reading performances were made at the time of recording on a pupil data sheet, a copy of which is included in Appendix A.

The fourth step in the research procedures, pitch meter analysis of the recorded voices, will be described in the following chapter.

Summary

The study population was composed of 160 elementary school children in grades two, four, and six from two schools in a city near Boston. Educational achievement and intelligence data were collected for the population. Selected materials and techniques were used to obtain tape recordings of five different oral activities of each child. The tape recorded voices constituted the primary material from which vocal pitch data were taken for pitch meter and statistical analysis.

CHAPTER IV

METHODS OF ANALYZING PITCH OF THE VOICE

The Purdue pitch meter was used to select, count, and record the fundamental frequencies of the tape recorded voices used by children in speaking, reading, and recall of reading. Before pitch analysis was begun, specific assumptions were made:

1. Electromagnetic recordings do not distort pitch.[1]
2. The pitch of a musical sound is determined primarily by its fundamental frequency.[2]
3. The Purdue pitch meter is an improved instrument for extracting fundamental frequencies from complex speech sounds.[3]

The Purdue Pitch Meter

<u>Pitch meter task</u>.-- The design and operation of the Purdue pitch meter are described in Chapter II and Appendix A. In brief, its action consists of: (1) taking speech from a microphone; (2) amplifying the speech sounds; (3) counting the cycles per second of the fundamental (lowest) frequency; (4) indicating that fundamental on a metered scale

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[1]Skinner, <u>op. cit</u>., p. 81.

[2]Lawrence E. Kinsler and Austin R. Frey, <u>Fundamentals of Acoustics</u>, p. 377. New York: John Wiley & Sons, Inc., 1950.

[3]Dempsey and others, <u>op. cit</u>., pp. 135-41.

calibrated in cycles per second; and (5) graphically recording the fundamental frequency on a chart.

Pitch meter equipment.-- A Purdue pitch meter for use in this study was constructed by the Physics Department of Boston University from diagrams of circuits designed by Dempsey and others.[4] An Esterline-Angus recording milliammeter, style 424-A,[5] using Esterline-Angus chart 4313-A,[6] was added to the Purdue pitch meter to produce the permanent visual record of fundamental frequencies from which the raw data for the present study were taken. The line drawn by the recording milliammeter represents the fundamental frequency of the voice exclusive of harmonics, articulation, or intensity factors. A sample of the chart record appears in Appendix A.

Range selection.-- The Purdue pitch meter had three ranges, 50-100, 100-500, and 200-1000 cps, to make it adaptable to the fundamental frequencies of any speaking voice. Since only children's voices were to be analyzed in the present study, it was necessary to select from the three ranges the one most sensitive to their voices. Previous studies of children's voices reported pitch values near Middle C, in the vicinity of 261 cps. In the light of this information, the 50-250 cps range was too low. The highest range, 200-1000 cps, would have covered all the pitches except perhaps those of a few sixth-grade boys whose voices were beginning to change. Nevertheless, the range was not used since Dempsey and

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[4] Ibid., pp. 138-39.

[5] Manufactured by the Esterline-Angus Company, Inc., Indianapolis, Indiana.

[6] Ibid.

others,[7] who designed the machine, suggested that the range should show most of the indications in the upper four fifths of the meter scale. Just the opposite would have been true for children's voices on the 200-1000 cps range. The middle range covered the frequencies reportedly used by children and would indicate those frequencies in the upper four fifths of the range, as suggested. These factors gave sufficient reason for choosing the 100-500 cps range. The range selector switch was then set in the middle range position.

Reference oscillator setting.-- One problem in the use of the Esterline-Angus milliammeter is the delay in the movement of the recording pen. The pen is slow in moving from "rest" position at the bottom of the selected range to the frequency of the signal applied from the meter. Since the rate of frequency change of the speaking voice is very rapid, the recording pen does not ordinarily have time to reach the exact voice frequency before another signal is applied. To eliminate some of this "lag" due to the slow climb and drop of the pen, a reference oscillator is used to provide a "return" level for the recording instrument. It should be explained that this reference oscillator, built into the Purdue pitch meter, feeds a constant tone into the pitch analyzer circuit of the pitch meter. It may be adjusted to any tone between 50 and 800 cps with a separate switch on the meter panel. It permits the recording instrument to rest in what might be called a "middle of the road" position, that is, in approximately the center of the range of frequencies being measured. When the oscillator is in operation and no other signal is

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[7]Dempsey and others, op. cit., p. 137.

applied, the recording instrument indicates the oscillator frequency. As soon as a voice signal of adequate intensity enters the circuit, the fundamental frequency of the voice signal is indicated. Between voice signals, the indicator returns to the oscillator frequency. This adjustable "return" or reference level increases the speed of response of the meter since the movement does not start at the bottom of the range, but at a point near the mean pitch of the voice.

A study was made to locate a critical "return" setting for the reference oscillator at a point on the 100-500 cps range. The speaking, reading, and recall voices of one fourth-grade boy and one sixth-grade girl were introduced by microphone into the pitch meter with the reference oscillator arbitrarily set at 150 cps near the lower limit of the 100-500 cps range. The fundamental frequency count was drawn on a ruled chart by the recording milliammeter in response to signals from the pitch meter. Next, the same voices were analyzed with the reference oscillator at 200 cps. A chart was drawn as before. Finally, a reference tone of 250 cps was used for a third run of the same voices. This procedure yielded three separate charts containing the visual records of the voices. Inspection of the charts showed that they were similar in contour, which indicated that the recording instrument was registering the pitch variations consistently for all three reference positions. In order to determine which reference level would show pitch with the greatest accuracy, range, mean, and standard deviation were computed for the pitch readings from each of the three charts.

TABLE 6

VOICE FREQUENCIES AT THREE PITCH METER REFERENCE SETTINGS

Reference Setting (cps)	Range (cps)	Mean (cps)	S.D.
150	150-210	180.0	13.42
200	150-220	196.9	16.90
250	150-220	191.2	15.99

Table 6 shows that the lowest setting, 150 cps, produced the narrowest range, lowest mean pitch, and the smallest standard deviation, indicating comparatively poor selectivity of fundamental frequencies for the voices being studied. Inspection of mean frequencies shows that the difference between the 200 and the 250 cps means was slight; therefore, they could be considered close to the true mean. Either reference setting could have been used. The slightly greater standard deviation shown by the 200 cps reference indicated slightly greater sensitivity. However, it was felt that the slight difference in the size of the standard deviations was not enough to warrant a clear choice of one or another setting. It was noted then that the variation of mean pitch from the reference point was much greater for the 250 cps setting than for either of the other two. Because the instrument could record pitches relatively far from the 250 cps setting without appreciable loss of variation of pitch, as shown by the standard deviation, the reference oscillator was left at 250 cps.

Before the analysis for the main study was undertaken, the calibration of the instrument was checked by the technician who built it.

After half the voices had been analyzed, the calibration was rechecked.

Operating procedures.-- The procedures given below were followed to put the Purdue pitch meter in operation:

1. Place the Purdue pitch meter in a soundproof room.
2. Thread a reel of tape recorded voice samples on the tape recorder.
3. Turn on the power supply for the tape recorder.
4. Adjust the playback volume.
5. Place the microphone about 15 inches away from the loud-speaker grill in the tape recorder. Microphone faces the loud-speaker.
6. Connect the microphone to the pitch meter.
7. Turn on the power supply for the pitch meter.
8. Set the range selector switch on the middle range, 100-500 cps.
9. Set the reference level at 250 cps on the 100-500 cps range.
10. Set the pitch meter volume so that the lamp on the meter panel glows when a signal is applied. (Not critical.)
11. Run the pitch meter without playing the recorder to obtain a reference line of 250 cps on the milliammeter chart.
12. Run the tape recorder in playback position.
13. Observe the milliammeter constantly while it is operating to mark the beginning and end of each selection and to cancel all nonvocal sections on the chart line being drawn by the recording pen.
14. Check reference level setting after each child's recording. (See step 9 above.)

15. Repeat steps 11 to 14 for each voice sample.

16. Recheck the meter volume occasionally. (Step 10.)

Reliability Studies

Reliability of scoring the pitch of voice recordings.-- Tests of reliability were made to determine the stability of the pitch meter analysis and methods of scoring the recordings from the pitch meter. The voice recordings, referred to in the following paragraphs and described in detail in Appendix A, represent the fundamental frequency of the voice as counted and drawn on a chart by the Purdue pitch meter from a range setting of 100-500 cps and a reference frequency of 250 cps. The chart itself consists of small vertical sections representing 10 cycles per second and horizontal sections, each representing four seconds of speaking time.

To determine the reliability of the consistency of the voice recordings and a method of scoring them, two charts were drawn for duplicate meter runs of 10 voice samples, each approximately one minute long. Full scoring of each voice recording was made by taking one pitch measurement for each second of speaking time, giving a total of nearly 60 pitch readings per sample. Variations of pitch occurring within one second were averaged by inspection. All pitch readings were adjusted to the lower limits of intervals of multiples of 10 cps. For example, frequencies averaging between 240 and 250 cps per second of speaking time were read as 240 cps. The mean was computed for the total pitch readings of each sample. The reliability of scoring was determined by rank difference correlation using the Spearman formula: $\text{rho} = 1 - \frac{6 \sum d^2}{n(n^2-1)}$

A reliability coefficient of .90 ± .063 was obtained, which was sufficiently high to warrant conclusions being drawn from comparisons of different samples of vocal pitch analyzed by the Purdue pitch meter and scored by the technique just described.

Reliability of an abridged technique of scoring the pitch of voice recordings.-- Another check was made on the reliability of scoring by comparing partial scoring with full scoring of 30 speaking voice samples. The abridged technique involved scoring pitch for the first second of speaking time occurring to the left of each vertical dividing line on the chart. Means were computed for both full and abridged pitch measurements for each of the 30 voice recordings. The Spearman rank difference correlation formula, given previously, was used to obtain a reliability coefficient of .99 ± .003. The high degree of consistency between the abridged and full methods of scoring the recordings justified the use of the abridged scoring technique in subsequent research.

Reliability of sample of vocal pitch.-- The reliability of the vocal pitch sample was determined by a third study for which pitch meter recordings of 38 reading voice samples were checked against the same number of samples obtained from the identical population reading an equivalent paragraph one week later. There was a marked to high consistency (rho = .84 ± .048) between the recordings of an individual's voice in two situations. Such a degree of consistency appeared to justify the use of the voice recording from the pitch meter for further analysis of speaking and oral reading activities.

Summary

The first step in analyzing pitch of the voice from tape recordings was performed by the Purdue pitch meter, a machine which detects sound waves and changes them in such a way that they may be counted. A recording milliammeter was added to the pitch meter to provide a permanent visual record of pitch. The "lag" in the movement of the milliammeter was somewhat eliminated by the use of a selected range and a "return level" reference tone appropriate to the pitch range of the voices analyzed. A uniform procedure was followed to operate the pitch meter. Studies of meter constancy, two techniques of scoring the recordings, and the consistency of voice samples resulted in reliability coefficients high enough to warrant further research using the selected materials and methods developed for this study of vocal pitch.

CHAPTER V

ANALYSIS OF THE DATA

It was the purpose of this study to investigate children's use of vocal pitch in (1) conversational speaking, (2) easy reading, (3) unaided recall of easy reading, (4) difficult reading, and (5) unaided recall of difficult reading at grades two, four, and six. The data were analyzed to determine:

1. The average fundamental frequency of the voice in each of the five oral activities.
2. The range of mean vocal pitches in each of the five oral activities.
3. If significant differences exist between the mean vocal pitches in the five variables at grades two, four, and six.
4. If significant differences exist between the mean vocal pitches used by each sex in each of the five variables at grades two, four, and six.
5. If significant differences exist in the mean vocal pitches within grades two, four, and six
   a. Among the five variables
   b. In each variable
      (1) Between boys and girls
      (2) Between pupils of low and high intelligence
      (3) Between pupils of low and high achievement.

Groupings for the Analysis

The data were analyzed according to the following groupings:

1. Grade levels.-- The 160 children comprising the total population of the study were distributed in grades two, four, and six as shown in Table 1.
2. Sex.-- The distribution of boys and girls at each grade level is shown in Table 1.
3. Intelligence.-- The population for each grade was divided into thirds according to intelligence quotients obtained from the California Short-Form Test of Mental Maturity.[1] The pitch data for the lower and upper thirds were selected for analysis. Table 7 shows the I.Q. range for each group.

TABLE 7

INTELLIGENCE GROUPS FOR PITCH DATA ANALYSIS

Grade	I.Q. Scores: Lower Third		Upper Third	
	Number	Range	Number	Range
2	17	88-112	17	122-147
4	17	78-91	17	111-143
6	19	75-106	19	117-131

Each lower third and upper third intelligence group included 17 children from each of grades two and four, and 19 children from grade six. The lower intelligence groups with I.Q.'s

[1]Sullivan and others, loc. cit.

from 75 to 112 seem to have slightly higher ranges than the general school population. The upper groups appear to have normal intelligence ranges, with I.Q.'s from 111 to 147.

4. Educational achievement.-- The lower and upper thirds of each grade, as determined by the grade equivalent scores from the Metropolitan Achievement Tests,[2] were selected for analysis of pitch data. Table 8 shows the grade equivalent ranges for the two achievement groups at each grade level.

TABLE 8

EDUCATIONAL ACHIEVEMENT GROUPS FOR PITCH DATA ANALYSIS

Grade (year and month)	Educational Achievement Scores (grade equivalents)			
	Lower Third		Upper Third	
	Number	Range	Number	Range
2.9	17	2.3-3.2	17	3.7-4.9
4.9	17	4.2-4.9	17	6.1-7.8
6.9	19	5.8-7.4	19	9.0-10.9

Each of the lower third and upper third educational achievement groups included 17 children from each of grades two and four, and 19 children from grade six. The achievement range for the lower groups extended from a year below to a few months above the grade levels. The upper groups represented an achievement spread from nearly one year to four years above the grade levels at the time of testing. Both lower and

[2]Hildreth, loc. cit.

upper groups appear to have slightly higher ranges than the general school population.

Comparisons of Pitch of the Voice in Five Oral Activities

Data for statistical analysis given below were derived from children's tape-recorded voices which were processed by the Purdue pitch meter to obtain a fundamental frequency count. The resulting pitch meter chart records of fundamental frequency were scored by the writer and the mean pitch of the voice of each child in each of five variables was computed. These data were then grouped and regrouped according to grade level, sex, intelligence, and educational achievement, for statistical analysis.

A mean pitch shown in the following frequency distributions is the mean of individual pitches used by one pupil in an oral activity. Mean pitch as used in the comparisons of vocal pitch represents an average of the mean pitches used by the members of a group.

For purposes of this study, the 5 per cent level of confidence, which means 95 chances in 100 of a true difference, was selected as the criterion for significance. Because of the similarity between the elements measured and the preciseness of the measures used, the 5 per cent level was considered sufficiently stringent.

<u>Pitch of the voice in five variables at grades two, four, and six</u>.-- The following comparisons were made to determine if significant differences exist in the mean vocal pitch used in each oral activity at three grade levels. The range and distribution of mean pitches used in speaking are shown in Table 9.

TABLE 9

FREQUENCY DISTRIBUTION OF MEAN PITCHES IN SPEAKING AT GRADES TWO, FOUR, AND SIX

Range and Fundamental Frequency (cps)	Grade 2 N 51	Grade 4 N 52	Grade 6 N 57
268-270	1	1	
265-267	0	1	
262-264	3	3	
259-261	10	4	4
256-258	9	8	7
253-255	7	8	8
250-252	11	12	32
247-249	7	5	2
244-246	1	6	2
241-243	2	1	0
238-240		1	2
235-237		1	
232-234		0	
229-231		1	
Mean (cps)	254.5	252.6	252.0
S.D.	5.66	7.16	4.26
Range (cps)	242.0-268.0	231.3-269.4	238.6-260.7

Grade six has the smallest range and standard deviation of 4.26, showing the least variability of pitch. Grade four has the largest range and a standard deviation of 7.16 which shows the greatest variability of mean speaking pitch for the three grades studied.

Table 10 shows the comparison of speaking pitches at grades two, four, and six.

TABLE 10

COMPARISON OF SPEAKING PITCHES
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	51	254.5	5.66	.80	1.9	1.28	1.48
4	52	252.6	7.16	1.00			
4	52	252.6	7.16	1.00	.6	1.15	.53
6	57	252.0	4.26	.57			
2	51	254.5	5.66	.80	2.5	.98	2.55
6	57	252.0	4.26	.57			

The mean pitch of voice in speaking at grade two is 254.5 cps compared to a lower mean speaking pitch of 252.6 cps at grade four. The difference of the means is 1.9 cps. The critical ratio of 1.48 shows that the difference is not significant.

A mean speaking pitch of 252.6 cps at grade four is .6 cps above the mean pitch of 252.0 cps at grade six. The critical ratio of .53 indicates that the difference is not significant.

Grade six mean speaking pitch is 252.0 cps which is 2.5 cps below the grade two mean of 254.5 cps. The critical ratio of 2.55 shows the difference is significant.

The range and distribution of mean pitches used in easy reading at three grade levels are shown in Table 11.

TABLE 11

FREQUENCY DISTRIBUTION OF MEAN PITCHES IN EASY READING AT GRADES TWO, FOUR, AND SIX

Range and Fundamental Frequency (cps)	Grade 2 N 51	Grade 4 N 52	Grade 6 N 57
280-282		1	
277-279		2	
274-276		2	
271-273	4	4	1
268-270	1	4	4
265-267	6	7	8
262-264	5	6	7
259-261	7	7	17
256-258	8	5	5
253-255	11	6	5
250-252	5	0	7
247-249	2	3	1
244-246	2	1	1
241-243		2	0
238-240		0	1
235-237		0	
232-234		1	
229-231		1	
Mean (cps)	258.5	260.6	259.5
S.D.	6.71	10.81	6.55
Range (cps)	245.5-273.3	229.0-280.8	239.0-272.8

Grade four has the largest range and a standard deviation of 10.81, therefore, greater mean pitch variability in easy reading than grade two or six with standard deviations of 6.71 and 6.55, respectively.

Table 12 shows the comparison of pitches in easy reading at grades two, four, and six.

TABLE 12

COMPARISON OF PITCHES IN EASY READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	51	258.5	6.71	.95	2.1	1.79	1.16
4	52	260.6	10.81	1.51			
4	52	260.6	10.81	1.51	1.1	1.75	.59
6	57	259.5	6.55	.88			
2	51	258.5	6.71	.95	1.0	1.29	.81
6	57	259.5	6.55	.88			

Table 12 shows that the mean pitch in easy reading at grade two is 258.5 cps compared to a higher mean pitch of 260.6 cps at grade four. The difference of the means is 2.1 cps which yields a critical ratio of 1.16 and is not significant.

Grade four has a mean pitch in easy reading of 260.6 cps which is 1.1 cps higher than grade six mean of 259.5 cps. The critical ratio is .59 and is not significant.

The mean pitches in easy reading for grades two and six are 258.5 cps and 259.5 cps, respectively. Although the easy reading pitch at grade six is 1.0 cps higher than at grade two, the critical ratio of .81 is not significant.

No significant differences are found in mean pitch in easy reading between grade levels.

Table 13 gives the range and distribution of mean pitches in unaided recall of easy reading at three grade levels.

TABLE 13

FREQUENCY DISTRIBUTION OF MEAN PITCHES
IN UNAIDED RECALL OF EASY READING
AT GRADES TWO, FOUR, AND SIX

Range and Fundamental Frequency (cps)	Grade 2 N 51	Grade 4 N 52	Grade 6 N 57
271-273		1	
268-270	1	0	2
265-267	2	6	2
262-264	2	7	4
259-261	12	5	6
256-258	2	6	8
253-255	11	7	15
250-252	13	7	16
247-249	5	4	2
244-246	2	3	1
241-243	1	4	0
238-240		0	1
235-237		2	
232-234		1	
Mean (cps)	254.8	254.6	255.
S.D.	5.17	8.69	5.68
Range (cps)	242.3-268.3	234.0-273.3	240.0-269.2

Table 13 shows that grade two has the least variability of mean pitch in unaided recall of easy reading as revealed by the smallest range and a standard deviation of 5.17. Grade four has the largest range and a standard deviation of 8.69, which indicates greatest variability of mean pitch in unaided recall of easy reading.

Table 14 shows the comparisons of mean pitch in unaided recall of easy reading at three grade levels.

TABLE 14

COMPARISON OF PITCHES IN UNAIDED RECALL OF EASY READING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	51	254.8	5.17	.81	.2	1.46	.14
4	52	254.6	8.69	1.22			
4	52	254.6	8.69	1.22	.5	1.43	.34
6	57	255.1	5.68	.76			
2	51	254.8	5.17	.81	.3	1.11	.27
6	57	255.1	5.68	.76			

The mean pitch in unaided recall of easy reading at grade two is 254.8 cps, as shown in Table 14. The mean pitch at grade four is 254.6 cps. The difference of .2 cps between the means gives a critical ratio of .14 which is not significant.

Grade four, with a mean pitch of 254.6 cps in unaided recall of easy reading, has a pitch .5 cps lower than grade six with a mean pitch of 255.1 cps. The critical ratio of the difference is .34 which is not significant.

Grade six shows a mean pitch of 255.1 cps in unaided recall of easy reading which is .3 cps higher than the grade two mean of 254.8 cps.

The critical ratio is .27 and not significant.

No significant differences are found between grade levels for mean pitch in unaided recall of easy reading.

Table 15 shows range and frequency distribution of mean pitches in difficult reading at three grade levels.

TABLE 15

FREQUENCY DISTRIBUTION OF MEAN PITCHES IN DIFFICULT READING AT GRADES TWO, FOUR, AND SIX

Range and Fundamental Frequency (cps)	Grade 2 N 51	Grade 4 N 52	Grade 6 N 57
283-285			1
280-282		1	0
277-279		0	0
274-276		1	1
271-273		0	1
268-270	1	6	4
265-267	5	8	5
262-264	6	8	8
259-261	13	7	12
256-258	9	5	8
253-255	7	3	7
250-252	3	3	6
247-249	5	4	2
244-246	1	2	2
241-243	1	0	0
238-240		2	
235-237		2	
Mean (cps)	257.6	258.8	259.3
S.D.	5.96	9.80	7.39
Range (cps)	241.7-269.3	235.3-282.0	244.2-282.7

Of the three grades studied, grade four has the greatest mean pitch variability in difficult reading as indicated in Table 15 by the widest range and a standard deviation of 9.80. Grade two has the least variability of difficult reading pitch with the smallest range and a standard deviation of 5.96.

Comparisons of pitch in difficult reading at three grade levels are given in Table 16.

TABLE 16

COMPARISON OF PITCHES IN DIFFICULT READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	51	257.6	5.96	.84	1.2	1.61	.75
4	52	258.8	9.80	1.37			
4	52	258.8	9.80	1.37	.5	1.69	.28
6	57	259.3	7.39	.99			
2	51	257.6	5.96	.84	1.7	1.30	1.30
6	57	259.3	7.39	.99			

Table 16 shows that grade two with a mean pitch of 257.6 cps has the lowest pitch of the three grades in difficult reading. The difference between means of grades two and four is 1.2 cps. The critical ratio is .75 and not significant.

Grade four with a mean pitch of 258.8 cps and grade six with a higher mean pitch of 259.3 cps show a mean difference of .5 cps. A critical ratio of .28 is not significant.

Grade two has a mean pitch of 257.6 cps for difficult reading which is 1.7 cps lower than grade six with a pitch of 259.3 cps. The critical ratio of 1.30 shows that the difference is not significant.

No significant differences appear between the mean pitches in difficult reading at the three grade levels.

The range and distribution of mean pitches in unaided recall of difficult reading at three grade levels are shown in Table 17.

TABLE 17

FREQUENCY DISTRIBUTION OF MEAN PITCHES IN UNAIDED RECALL OF DIFFICULT READING AT GRADES TWO, FOUR, AND SIX

Range and Fundamental Frequency (cps)	Grade 2 N 51	Grade 4 N 52	Grade 6 N 57
271-273		2	1
268-270	1	0	1
265-267	1	4	2
262-264	2	6	4
259-261	11	6	2
256-258	9	10	11
253-255	8	6	10
250-252	9	4	15
247-249	7	4	8
244-246	2	4	0
241-243	0	1	2
238-240	1	4	1
235-237		1	
Mean (cps)	254.6	254.7	254.2
S.D.	5.76	8.37	6.12
Range (cps)	239.1-270.0	237.0-272.0	240.0-271.7

Table 17 shows approximately the same mean pitch range for all grades in unaided recall of difficult reading. Grade four has a slightly wider range and a standard deviation of 8.37 which is indicative of slightly greater variability when compared with grades two and six, whose standard deviations are 5.76 and 6.12, respectively.

Table 18 shows comparisons of pitch in unaided recall of difficult reading at three grade levels.

TABLE 18

COMPARISON OF PITCHES IN UNAIDED RECALL OF DIFFICULT READING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	51	254.6	5.76	.81	.1	1.42	.06
4	52	254.7	8.37	1.17			
4	52	254.7	8.37	1.17	.5	1.43	.34
6	57	254.2	6.12	.82			
2	51	254.6	5.76	.81	.4	1.15	.34
6	57	254.2	6.12	.82			

Table 18 shows that the mean pitch in unaided recall of difficult reading at grade two is 254.6 cps and .1 cps lower than the mean pitch of 254.7 cps in the same variable at grade four. The critical ratio of .06 is low and statistically insignificant.

Grade four has a mean pitch of 254.7 cps in unaided recall of difficult reading, which is .5 cps higher than a mean pitch of 254.2 cps at grade six. The critical ratio of the difference is .34 and not significant.

Grades two and six, with mean pitches of 254.6 cps and 254.2 cps, respectively, show a mean difference of .4 cps in unaided recall of difficult reading. A critical ratio of .34 is not significant.

None of the critical ratios given in Table 18 shows a significant difference in mean pitch in unaided recall of difficult reading between grade levels.

Pitch of the voice in five variables within grades two, four, and six.-- Mean vocal pitches in the five oral activities were compared to determine significant differences existing between pitches within grade levels. The range and distribution of mean pitches in five variables at grade two are shown in Table 19.

TABLE 19

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF 51 SECOND-GRADE PUPILS

Range and Fundamental Frequency (cps)	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
271-273		4			
268-270	1	1	1	1	1
265-267	0	6	2	5	1
262-264	3	5	2	6	2
259-261	10	7	12	13	11
256-258	9	8	2	9	9
253-255	7	11	11	7	8
250-252	11	5	13	3	9
247-249	7	2	5	5	7
244-246	1	2	2	1	2
241-243	2		1	1	0
238-240					1
Mean (cps)	254.5	258.5	254.8	257.6	254.6
S.D.	5.66	6.71	5.17	5.96	5.76
Range (cps)	242.0-268.0	245.5-273.3	242.3-268.3	241.7-269.3	239.1-270.0

The combined range of mean pitch for all variables at grade two extends from 241.7 cps to 273.3 cps, as shown in Table 19. There is considerable similarity in the range of vocal pitch for the five variables. Easy reading has a standard deviation of 6.71 which is the largest for any variable and indicates the greatest variability of mean pitch among the five oral activities studied at grade two.

Table 20 shows a comparison of mean pitches in five oral activities within grade two.

TABLE 20

COMPARISON OF PITCHES IN FIVE ORAL ACTIVITIES
OF 51 SECOND-GRADE PUPILS

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	254.5	5.66	.80	4.0	1.24	3.23
Easy Reading	258.5	6.71	.95			
Speaking	254.5	5.66	.80	.3		
Unaided Recall of Easy Reading	254.8	5.17	.81	.3	1.14	.24
Speaking	254.5	5.66	.80	3.1	1.16	2.60
Difficult Reading	257.6	5.96	.84			
Speaking	254.5	5.66	.80	.1	1.14	.10
Unaided Recall of Difficult Reading	254.6	5.76	.81			
Easy Reading	258.5	6.71	.95	3.7	1.25	2.98
Unaided Recall of Easy Reading	254.8	5.17	.81			
Easy Reading	258.5	6.71	.95	.9	1.27	.72
Difficult Reading	257.6	5.96	.84			
Easy Reading	258.5	6.71	.95	3.9	1.25	3.11
Unaided Recall of Difficult Reading	254.6	5.76	.81			

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TABLE 20 (concluded)

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Unaided Recall of Easy Reading	254.8	5.17	.81	2.8	1.17	2.40
Difficult Reading	257.6	5.96	.84			
Unaided Recall of Easy Reading	254.8	5.17	.81	.2	1.14	.14
Unaided Recall of Difficult Reading	254.6	5.76	.81			
Difficult Reading	257.6	5.96	.84	3.0	1.17	2.54
Unaided Recall of Difficult Reading	254.6	5.76	.81			

At grade two the mean pitch in speaking is 254.5 cps and in easy reading, 258.5 cps. Table 20 shows that easy reading pitch raises 4.0 cps from the speaking pitch. The critical ratio is 3.23 which reveals that a change from speaking to easy reading at grade two is accompanied by a significant raise in vocal pitch.

The pitch used in unaided recall of easy reading is 254.8 cps and .3 cps above the speaking pitch at grade two. The critical ratio of .24 is not statistically significant.

A comparison of the speaking pitch of 254.5 cps and the difficult reading pitch of 257.6 cps reveals that the latter has a mean pitch 3.1 cps higher than speaking at grade two. The critical ratio of this difference is 2.60 which is statistically significant.

The mean speaking pitch at grade two is 254.5 cps and the mean pitch in unaided recall of difficult reading is 254.6 cps. The difference between the means is .1 cps. The critical ratio is .10 and not significant.

The mean pitch in easy reading is 258.5 cps and the mean pitch in unaided recall of easy reading is 254.8 cps. A lowering of 3.7 cps occurs from easy reading pitch to recall of easy reading pitch at grade two. A critical ratio of 3.0 is statistically significant.

The mean pitch of easy reading is 258.5 cps as compared to a lower mean pitch of 257.6 cps in difficult reading at grade two. The difference between the means is .9 cps. The critical ratio is .72 and not significant.

The mean pitches of easy reading and unaided recall of difficult reading are 258.5 cps and 254.6 cps, respectively. The mean pitch in recall of difficult reading is 3.9 cps below that of easy reading at grade two. The critical ratio of 3.11 is significant.

Unaided recall of easy reading has a mean pitch of 254.8 cps, while difficult reading has a higher mean of 257.6 cps at grade two. The difference in the means is 2.8 cps. The critical ratio of 2.40 shows a significant difference.

The mean pitch in unaided recall of easy reading is 254.8 cps compared to a mean of 254.6 cps in unaided recall of difficult reading. The difference in means is .2 cps. The critical ratio of this difference is .14 and statistically insignificant.

A mean pitch of 257.6 cps in difficult reading and a lower mean of 254.6 cps in unaided recall of difficult reading gives a mean difference of 3.0 cps. A critical ratio of 2.54 for this difference is significant at grade two.

Six of the 10 comparisons made of the mean vocal pitch between variables at grade two show significant differences.

The range and distribution of mean pitches in five variables at grade four are shown in Table 21.

TABLE 21

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES OF 52 FOURTH-GRADE PUPILS

Range and Fundamental Frequency (cps)	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
280-282		1		1	
277-279		2		0	
274-276		2		1	
271-273		4	1	0	2
268-270	1	4	0	6	0
265-267	1	7	5	8	3
262-264	3	6	8	8	7
259-261	5	8	4	7	6
256-258	8	4	7	5	10
253-255	7	6	7	3	6
250-252	12	0	7	3	4
247-249	5	3	4	4	4
244-246	6	1	2	2	4
241-243	1	2	4	0	1
238-240	1	0	0	2	4
235-237	1	0	2	2	1
232-234	0	1	1		
229-231	1	1			
Mean (cps)	252.6	260.6	254.6	258.8	254.7
S.D.	7.16	10.81	8.69	9.80	8.37
Range (cps)	231.3-269.4	229.0-280.8	234.0-273.3	235.3-282.0	240.0-271.7

Table 21 shows that the combined range of mean pitch for all variables at grade four extends from 229.0 cps to 282.0 cps. There is marked variation in the ranges. Easy reading has the widest pitch range and the greatest variability as indicated by a standard deviation of 10.81. Unaided recall of difficult reading has the shortest range. Speaking is the least variable with a standard deviation of 7.16.

Table 22 shows a comparison of mean pitches in five variables within grade four.

TABLE 22

COMPARISON OF PITCHES IN FIVE ORAL ACTIVITIES OF 52 FOURTH-GRADE PUPILS

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	252.6	7.16	1.00	8.0	1.81	4.40
Easy Reading	260.6	10.18	1.51			
Speaking	252.6	7.16	1.00	2.0	1.58	1.23
Unaided Recall of Easy Reading	254.6	8.69	1.22			
Speaking	252.6	7.16	1.00	6.2	1.70	3.64
Difficult Reading	258.8	9.80	1.37			
Speaking	252.6	7.16	1.00	2.1	1.54	1.36
Unaided Recall of Difficult Reading	254.7	8.37	1.17			

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TABLE 22 (concluded)

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Easy Reading	260.6	10.18	1.51			
Unaided Recall of Easy Reading	254.6	8.69	1.22	6.0	1.94	3.10
Easy Reading	260.6	10.18	1.51			
Difficult Reading	258.8	9.80	1.37	1.8	2.04	.88
Easy Reading	260.6	10.18	1.51			
Unaided Recall of Difficult Reading	254.7	8.37	1.17	5.9	1.91	3.08
Unaided Recall of Easy Reading	254.6	8.69	1.22			
Difficult Reading	258.8	9.80	1.37	4.2	1.83	2.31
Unaided Recall of Easy Reading	254.6	8.69	1.22			
Unaided Recall of Difficult Reading	254.7	8.37	1.17	.1	1.69	.08
Difficult Reading	258.8	9.80	1.37			
Unaided Recall of Difficult Reading	254.7	8.37	1.17	4.1	1.80	2.27

Table 22 shows that the mean speaking pitch at grade four is 252.6 cps. The mean pitch of easy reading is 260.6 cps which is 8.0 cps higher than the speaking pitch. The critical ratio of the difference is 4.40 which is very significant and shows the difference in mean pitch is not due to chance factors.

In speaking, the mean pitch is 252.6 cps compared to the higher mean of 254.6 cps in unaided recall of easy reading for fourth grade pupils. The difference of the means is 2.0 cps. The critical ratio of 1.23 shows that the difference is not significant.

A comparison of pitch means at grade four reveals that difficult reading, with a mean of 258.8 cps, is 6.2 cps higher than speaking with a mean of 252.6 cps. The critical ratio of the difference is 3.64 and highly significant.

The mean pitch in speaking is 252.6 cps for fourth grade pupils and the mean pitch in unaided recall of difficult reading is higher at 254.7 cps. The difference of the means is 2.1 cps. The critical ratio is 1.36 and not significant.

The mean pitch is 260.6 cps in easy reading at grade four, which is 6.0 cps higher than the unaided recall of easy reading pitch at 254.6 cps. The difference yields a critical ratio of 3.10 and is statistically significant.

At the same grade level, the mean pitch in easy reading is 260.6 cps and in difficult reading 258.8 cps. The difference in the means is 1.8 cps with a critical ratio of .88 which is not significant.

The mean pitch in easy reading at grade four is 260.6 cps. The mean pitch in unaided recall of difficult reading is 254.7 cps. The mean difference is 5.9 cps. The critical ratio of 3.08 indicates that the difference between the means is statistically significant and not due to chance.

The mean pitch in unaided recall of easy reading is 254.6 cps at fourth grade, which is 4.2 cps lower than 258.8 cps, the mean pitch of difficult reading. The critical ratio of the difference is 2.31 which is significant.

Also at grade four, unaided recall of easy reading and unaided recall of difficult reading with mean pitches of 254.6 cps and 254.7 cps, respectively, have a mean difference of .1 cps. The critical ratio is .08 and not statistically significant.

The mean pitch in difficult reading at grade four is 258.8 cps as compared to a lower mean pitch in unaided recall of difficult reading of 254.7 cps. The difference between these means is 4.1 cps. The critical ratio of 2.27 represents a significant difference.

Six of the 10 comparisons made of the mean vocal pitch between variables at grade four show significant differences.

The range and distribution of mean pitches in five variables at grade six are shown in Table 23.

TABLE 23

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF 57 SIXTH-GRADE PUPILS

Range and Fundamental Frequency (cps)	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
283-285				1	
280-282				0	
277-279				0	
274-276				1	
271-273		1		1	1
268-270		3	2	4	1
265-267		8	2	5	2
262-264		8	4	8	4
259-261	5	17	6	12	2
256-258	6	5	8	8	11
253-255	10	5	15	7	10
250-252	30	7	16	6	15
247-249	2	1	2	2	8
244-246	2	1	1	2	0
241-243	0	0	0		2
238-240	2	1	1		1
Mean (cps)	252.0	259.5	255.1	259.3	254.2
S.D.	4.26	6.55	5.68	7.39	6.12
Range (cps)	238.6-260.7	239.0-272.8	240.0-269.2	244.2-282.7	240.0-271.7

The combined range of mean pitch for all variables at grade six extends from 238.6 to 282.7 cps as shown in Table 23. There is marked variation in the ranges among the variables. Difficult reading has the greatest variability as indicated by the largest range and a standard deviation of 7.39. Speaking has least variability as shown by the smallest range and a standard deviation of 4.26.

Table 24 presents a comparison of mean pitches in five variables within grade six.

TABLE 24

COMPARISON OF PITCHES IN FIVE ORAL ACTIVITIES
OF 57 SIXTH-GRADE PUPILS

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	252.0	4.26	.57	7.6	1.05	7.19
Easy Reading	259.5	6.55	.88			
Speaking	252.0	4.26	.57	3.1	.95	3.23
Unaided Recall of Easy Reading	255.1	5.68	.76			
Speaking	252.0	4.26	.57	7.3	1.70	4.28
Difficult Reading	259.3	7.39	.99			
Speaking	252.0	4.26	.57	2.2	1.00	2.22
Unaided Recall of Difficult Reading	254.2	6.12	.82			
Easy Reading	259.5	6.55	.88	4.4	1.16	3.86
Unaided Recall of Easy Reading	255.1	5.68	.76			
Easy Reading	259.5	6.55	.88	.3	1.32	.21
Difficult Reading	259.3	7.39	.99			
Easy Reading	259.5	6.55	.88	5.3	1.20	4.44
Unaided Recall of Difficult Reading	254.2	6.12	.82			

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TABLE 24 (concluded)

Variable	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Unaided Recall of Easy Reading	255.1	5.68	.76	4.2	1.25	3.36
Difficult Reading	259.3	7.39	.99			
Unaided Recall of Easy Reading	255.1	5.68	.76	.9	1.12	.76
Unaided Recall of Difficult Reading	254.2	6.12	.82			
Difficult Reading	259.3	7.39	.99	5.1	1.28	3.95
Unaided Recall of Difficult Reading	254.2	6.12	.82			

Table 24 shows that speaking, with a mean pitch of 252.0 cps at grade six, is 7.6 cps lower than easy reading, with a mean pitch of 259.5 cps. The critical ratio of 7.19 is highly significant.

The mean pitch in speaking is 252.0 cps compared to a higher mean pitch of 255.1 cps in unaided recall of easy reading at sixth grade. The difference between the means is 3.1 cps. The critical ratio of 3.23 is very significant.

A mean speaking pitch of 252.0 cps is 7.3 cps lower than the difficult reading pitch of 259.3 cps at grade six. The critical ratio of 4.28 shows the difference to be highly significant.

A comparison of sixth-grade means shows that speaking pitch at

252.0 cps is 2.2 cps lower than unaided recall of difficult reading at 254.2 cps. The critical ratio is 2.22 and statistically significant.

The mean pitch in easy reading at grade six is 259.5 cps. This is 4.4 cps higher than the mean pitch of 255.1 cps in unaided recall of easy reading. The critical ratio of 3.86 is very significant.

The sixth-grade mean pitch in easy reading is 259.5 cps. The mean pitch in difficult reading is 259.3 cps. The difference between the means is .3 cps. The critical ratio of .21 is not significant.

Easy reading at grade six with a mean pitch of 259.5 cps is 5.3 cps higher than unaided recall of difficult reading with a mean pitch of 254.2 cps. The critical ratio of 4.44 is highly significant.

Recall of easy reading has a mean pitch of 255.1 cps at grade six while difficult reading has a higher mean pitch of 259.3 cps. A mean difference of 4.2 cps gives a critical ratio of 3.36 which is significant.

The mean pitch in unaided recall of easy reading at grade six is 255.1 cps, and the mean pitch in unaided recall of difficult reading is 254.2 cps. The mean difference is .9 cps. The critical ratio is .76 and not significant.

Difficult reading with a mean pitch of 259.3 cps is 5.1 cps higher than unaided recall of difficult reading with a mean pitch of 254.2 cps. The critical ratio is 3.95 and highly significant.

Eight of the 10 comparisons made of the mean vocal pitch between variables at grade six show significant differences.

Sex differences in vocal pitch.-- Mean vocal pitches of boys and girls were compared within three grade levels to determine if significant differences exist between each variable. Range and distribution of mean pitches for both sexes in five variables at grade two are shown in Table 25.

TABLE 25

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF 29 BOYS AND 22 GIRLS AT GRADE TWO

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
272-273			2							
270-271			2						1	
268-269	1		1		1		1		0	
266-267	0		2	2	1		1	1	0	
264-265	2	1	2	2	1	1	4	1	1	
262-263	0	0	1	2	0	1	1	4	1	
260-261	3	2	3	2	4	3	3	3	2	5
258-259	4	3	1	4	3	3	3	5	4	2
256-257	5	2	3	2	1	0	4	3	4	4
254-255	1	4	1	5	3	6	4	0	2	4
252-253	2	4	5	2	2	0	3	1	3	2
250-251	5	2	3	0	7	6	0	2	2	5
248-249	1	3	2	0	2	1	2	2	4	1
246-247	3	1	1	1	3	1	1		3	1
244-245	0				0		1		1	
242-243	2				1		0		0	
240-241							1		0	
238-239									1	
Boys										
Mean (cps)	254.6		258.8		254.3		257.0		254.1	
S.D.	6.39		7.84		6.34		6.72		6.25	
Range (cps)	242.0-268.0		246.3-273.3		242.3-268.3		241.7-269.3		239.1-270.0	
Girls										
Mean (cps)	254.4		258.1		255.3		258.3		255.3	
S.D.	4.45		4.88		4.24		4.73		4.23	
Range (cps)	246.7-263.8		245.5-266.6		247.3-263.6		248.4-266.6		247.7-261.9	

A comparison of ranges at grade two reveals that boys have a wider range of mean vocal pitch than girls. Table 25 shows that in every activity the standard deviation is larger for boys than for girls, which indicates that boys tend to have greater variability of mean pitch in the oral activities studied. Boys' easy reading pitch is most variable among the five oral activities for both sexes at the second-grade level.

Comparison of pitches among the five variables for both sexes at grade two is shown in Table 26.

TABLE 26

COMPARISON OF VOCAL PITCHES
OF 29 BOYS AND 22 GIRLS AT GRADE TWO

Variable	Sex	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Boys	254.6	6.39	1.21	.2	1.55	.16
	Girls	254.4	4.45	.97			
Easy Reading	Boys	258.8	7.84	1.48	.7	1.82	.37
	Girls	258.1	4.88	1.07			
Unaided Recall of Easy Reading	Boys	254.3	6.34	1.20	1.0	1.52	.62
	Girls	255.3	4.24	.93			
Difficult Reading	Boys	257.0	6.72	1.27	1.3	1.63	.82
	Girls	258.3	4.73	1.03			

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TABLE 26 (concluded)

Variable	Sex	Mean (cps)	S.D.	S.E.$_m$	Diff.$_m$ (cps)	S.E.$_d$	C.R.
Unaided Recall of Difficult Reading	Boys	254.1	6.25	1.26	1.2	1.56	.80
	Girls	255.3	4.23	.92			

Table 26 shows a mean pitch in speaking of 254.6 cps for boys and 254.4 cps for girls at grade two. The difference between the means is .2 cps. The critical ratio is .16 which is not statistically significant.

In easy reading boys' mean pitch is 258.8 cps which is .7 cps higher than girls' mean pitch of 258.1 cps at the second-grade level. The critical ratio for this difference is .37 which is not significant.

Boys' mean pitch in unaided recall of easy reading at grade two is 254.3 cps. Girls' mean pitch is 255.3 cps. There is a mean difference of 1.0 cps. The critical ratio is .62 and not significant.

The mean pitch of voice for boys in difficult reading is 257.0 cps. The mean pitch for girls is 258.3 cps. The difference in the means is 1.3 cps. The critical ratio is .82 and not significant.

In unaided recall of difficult reading, boys with a mean pitch of 254.1 cps have a pitch level 1.2 cps lower than girls whose mean pitch is 255.3 cps. The critical ratio is .80 and not significant.

No statistically significant differences are found between mean pitches of boys and girls at grade two.

Range and distribution of mean pitches for both sexes in grade four are shown in Table 27.

TABLE 27

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF 31 BOYS AND 21 GIRLS AT GRADE FOUR

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
280-282			1					1		
277-279			1	1				0		
274-276			2	0			1	0		
271-273			4	0	1		0	0	1	1
268-270	1		0	4	0		4	2	0	0
265-267	1		5	2	5		5	3	2	1
262-264	3		3	3	7	1	6	2	4	3
259-261	3	2	5	3	2	2	3	4	4	2
256-258	5	3	1	3	3	4	3	2	7	3
253-255	2	5	3	3	3	4	2	1	3	3
250-252	9	3	0	0	3	4	2	1	3	1
247-249	2	3	3	0	3	1	3	1	1	3
244-246	2	4	0	1	1	1	0	2	2	2
241-243	1	0	1	1	2	2	0	0	1	0
238-240	0	1	0	0	0	0	1	1	2	2
235-237	1		0	0	1	1	1	1	1	
232-234	0		0	1		1				
229-231	1		1							
Boys										
Mean (cps)	253.4		261.3		256.6		259.3		254.9	
S.D.	8.07		11.10		8.70		8.86		8.35	
Range (cps)	231.3-269.4		229.0-280.8		237.3-273.3		236.7-274.3		237.0-272.0	
Girls										
Mean (cps)	251.5		259.5		251.5		258.0		254.3	
S.D.	5.29		10.23		7.61		11.02		8.45	
Range (cps)	240.1-260.7		233.0-278.0		234.0-262.1		235.3-282.0		239.4-271.7	

A comparison of the ranges in the five variables given in Table 27 shows that the overall pitch range is approximately the same for boys and girls. Closer inspection of the differences between the ranges for a single variable shows that boys tend to have mean pitches dispersed over a slightly wider range than girls in all but difficult reading. Boys maintain nearly the same variability of mean pitch in all but easy reading as indicated by the standard deviations. Girls show larger standard deviations and thus more variability of pitch in easy reading and difficult reading than in the other variables.

Table 28 shows a comparison of boys' and girls' vocal pitches in five oral activities at grade four.

TABLE 28

COMPARISON OF THE VOCAL PITCHES
OF 31 BOYS AND 21 GIRLS AT GRADE FOUR

Variable	Sex	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Boys	253.4	8.07	1.47	1.9	1.88	1.01
	Girls	251.5	5.29	1.18			
Easy Reading	Boys	261.3	11.10	2.03	1.8	3.06	.60
	Girls	259.5	10.23	2.29			
Unaided Recall of Easy Reading	Boys	256.6	8.70	1.59	5.1	2.33	2.21
	Girls	251.5	7.61	1.70			

(concluded on next page)

TABLE 28 (concluded)

Variable	Sex	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Difficult Reading	Boys	259.3	8.86	1.62	1.3	2.95	.45
	Girls	258.0	11.02	2.47			
Unaided Recall of Difficult Reading	Boys	254.9	8.35	1.52	.6	2.42	.26
	Girls	254.3	8.45	1.89			

At grade four, Table 28 shows that the mean pitch used in speaking by boys is 253.4 cps. Girls have a mean pitch of 251.5 cps. The mean difference is 1.9 cps. The critical ratio of 1.01 is not significant.

In easy reading, boys have a mean pitch of 261.3 cps which is 1.8 cps higher than the girls' mean pitch of 259.5 cps. The critical ratio is .60 and not significant.

Boys are found to have a pitch of 256.6 cps in unaided recall of easy reading at grade four. Girls have a mean pitch of 251.5 cps which is 5.1 cps lower than that of boys. The critical ratio is 2.21 and significant.

The mean pitch in difficult reading is 259.3 cps for boys and 258.0 cps for girls. Fourth-grade boys have a mean pitch 1.3 cps above that of girls. The critical ratio is .45 and statistically insignificant.

Unaided recall of difficult reading at grade four shows a mean pitch of 254.9 cps for boys and a similar pitch of 254.3 cps for girls.

The boys have a mean pitch .6 cps higher than girls. The critical ratio of .26 is not significant.

Table 29 shows the range and distribution of mean pitches for boys and girls in five oral activities at grade six.

TABLE 29

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF 33 BOYS AND 24 GIRLS AT GRADE SIX

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
283-285								1		
280-282								0		
277-279								0		
274-276							1	0		
271-273			1				0	1		1
268-270			2	1	2		3	1	1	0
265-267			6	2	0	2	4	1	2	0
262-264			3	5	2	2	6	2	3	1
259-261	2	3	11	6	4	2	6	6	1	1
256-258	4	2	3	2	5	3	5	3	6	5
253-255	5	5	3	2	10	5	4	3	6	4
250-252	16	14	2	5	9	7	2	4	6	9
247-249	1	1	1	0	0	2	1	1	6	2
244-246	0	2	0	1	1	0	1	1	0	0
241-243	0		0			0			1	1
238-240	2		1			1			1	
Boys										
Mean (cps)	252.6		260.4		255.8		259.7		254.6	
S.D.	3.95		6.90		5.37		6.61		6.47	
Range (cps)	244.0-260.7		239.0-272.8		246.0-269.2		244.2-276.0		240.0-269.1	
Girls										
Mean (cps)	251.2		258.4		254.0		258.6		253.7	
S.D.	4.36		6.00		5.97		8.14		5.69	
Range(cps)	238.6-258.5		245.0-269.4		240.0-265.5		245.3-282.7		242.0-271.7	

A comparison of the ranges shown in Table 29 reveals that speaking pitch is the least variable for both boys and girls. The range and standard deviation of girls' difficult reading pitch give evidence of the greatest variability of mean pitch among the distributions shown in Table 29. Close inspection of the distribution suggests that one very high mean pitch may be responsible for extending the range and standard deviation beyond the limits reached in other variables at grade six.

The results of a study to determine significant differences between the mean pitch levels of boys and girls in speaking and reading activities at grade six are shown in Table 30.

TABLE 30

COMPARISON OF THE VOCAL PITCHES
OF 33 BOYS AND 24 GIRLS AT GRADE SIX

Variable	Sex	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Boys	252.6	3.95	.70	1.4	1.15	1.17
	Girls	251.2	4.36	.91			
Easy Reading	Boys	260.4	6.90	1.22	2.0	1.75	1.11
	Girls	258.4	6.00	1.25			
Unaided Recall of Easy Reading	Boys	255.8	5.37	.95	1.8	1.56	1.19
	Girls	254.0	5.97	1.24			
Difficult Reading	Boys	259.7	6.61	1.17	1.1	2.06	.55
	Girls	258.6	8.14	1.70			

(concluded on next page)

TABLE 30 (concluded)

Variable	Sex	Mean (cps)	S.D.	S.E.$_m$	Diff.$_m$ (cps)	S.E.$_d$	C.R.
Unaided Recall of Difficult Reading	Boys	254.6	6.47	1.14	.9	1.65	.50
	Girls	253.7	5.69	1.19			

The mean speaking pitch for boys as shown in Table 30 is 252.6 cps. The mean speaking pitch for girls is 251.2 cps. The mean difference is 1.4 cps. The critical ratio is 1.17 which is not significant.

Boys' mean pitch in easy reading at sixth grade is 260.4 cps and girls' mean pitch is 258.4 cps. A comparison shows that boys use a pitch level 2.0 cps above that of girls. The critical ratio of 1.11 is not statistically significant.

In unaided recall of easy reading, boys' mean pitch is 255.8 cps which is 1.8 cps above the girls' mean pitch of 254.0 cps. The critical ratio is 1.19 and not significant.

The mean pitch of voice for boys in difficult reading is 259.7 cps. The mean pitch for girls is 258.6 cps. The difference between the means is 1.1 cps. The critical ratio is .55 which is not significant.

In unaided recall of difficult reading, boys have a mean pitch of 254.6 cps and girls have a mean pitch of 253.7 cps. The difference in means is .9 cps. The critical ratio is .50 and not statistically significant.

A higher pitch for boys in unaided recall of easy reading is the only significant difference to appear in the data comparing boys' and girls' vocal pitch at three grade levels.

<u>Pitch of the voice for each sex at grades two, four, and six</u>.--This study was made to disclose significant differences in mean vocal pitch for each sex from grade to grade. Frequency distributions of mean fundamental frequencies used by boys and girls in the five oral activities at grades two, four, and six can be found in Tables 25, 27, and 29. Table 31 shows a comparison of mean pitch for boys in speaking at three grade levels.

TABLE 31

COMPARISON OF BOYS' VOCAL PITCH IN SPEAKING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	29	254.6	6.39	1.21	1.2	3.58	.34
4	31	253.4	8.07	1.49			
4	31	253.4	8.07	1.49	.8	1.63	.49
6	33	252.6	3.95	.70			
2	29	254.6	6.39	1.21	2.0	1.40	1.46
6	33	252.6	3.95	.70			

The mean pitch of voice for boys at grade two is 254.6 cps. The mean pitch for boys in the same variable at grade four is 253.4 cps. The mean difference is 1.2 cps. The critical ratio is .34 which is not significant.

The mean pitch in speaking for boys at grade four was 253.4 cps and for the same variable, 252.6 cps at grade six. The difference in the means is .8 cps. The critical ratio is .49 and not significant.

The mean pitch of boys' voices in speaking at grade two is 254.6 cps, which is 2.0 cps higher than 252.6 cps, the mean speaking pitch used by boys at grade six. The critical ratio is 1.46 and not significant.

Table 32 shows a comparison of the mean vocal pitches used by boys in easy reading at three grade levels.

TABLE 32

COMPARISON OF BOYS' VOCAL PITCH IN EASY READING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	29	258.8	7.84	1.48	2.5	2.51	1.01
4	31	261.3	11.10	2.03			
4	31	261.3	11.10	2.03	.9	2.37	.41
6	33	260.4	6.90	1.22			
2	29	258.8	7.84	1.48	1.6	1.92	.82
6	33	260.4	6.90	1.22			

The mean pitch of boys' voices in easy reading at grade two is 258.8 cps compared to a mean pitch of 261.3 cps for boys at grade four. The difference of the means is 2.5 cps. The critical ratio is 1.01 which is not significant.

The mean pitch of voice in easy reading at grade four is 261.3 cps. The mean for boys in the same variable at grade six is 260.4 cps.

The difference between the means is .9 cps. The critical ratio is .41 and not significant.

Boys at grade two have a mean pitch in easy reading of 258.8 cps while boys at grade six have a mean of 260.4 cps. The difference in the means is 1.6 cps. The critical ratio is .82 and statistically insignificant.

Table 33 shows the difference in the mean vocal pitch of boys in unaided recall of easy reading at three grade levels.

TABLE 33

COMPARISON OF BOYS' VOCAL PITCH
IN UNAIDED RECALL OF EASY READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	29	254.3	6.34	1.20	2.3	2.00	1.65
4	31	256.6	8.70	1.59			
4	31	256.6	8.70	1.59	.8	1.85	.43
6	33	255.8	5.37	.95			
2	29	254.3	6.34	1.20	1.3	1.53	.98
6	33	255.8	5.37	.95			

The mean pitch of boys' voices in unaided recall of easy reading at grade two is 254.3 cps compared to a mean of 256.6 cps at grade four. The difference of the means is 2.3 cps. The critical ratio is 1.65 which is not significant.

The mean pitch of voice in unaided recall of easy reading for boys at grade four is 256.6 cps and at grade six it is 255.8 cps. The difference between the means is .8 cps. The critical ratio is .43 and not significant.

At grade two, boys have a mean pitch in unaided recall of easy reading of 254.3 cps, while boys at grade six have a mean pitch of 255.8 cps. The difference in the means is 1.5 cps. The critical ratio is .98 and not statistically significant.

Table 34 shows a comparison of the mean vocal pitches of boys in difficult reading at three grade levels.

TABLE 34

COMPARISON OF BOYS' VOCAL PITCH IN DIFFICULT READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	29	257.0	6.72	1.27	2.3	2.06	1.13
4	31	259.3	8.86	1.62			
4	31	259.3	8.86	1.62	.4	1.99	.21
6	33	259.7	6.61	1.17			
2	29	257.0	6.72	1.27	2.7	1.73	1.58
6	33	259.7	6.61	1.17			

The mean pitch of boys' voices in difficult reading at grade two is 257.0 cps compared to a mean pitch of 259.3 cps for boys at grade four.

The difference of the means is 2.3 cps. The critical ratio is 1.13 which is not significant.

The mean pitch of voice in difficult reading for boys at grade four is 259.3 cps and in the same variable at grade six it is 259.7 cps. The mean difference is .4 cps. The critical ratio is .21 and not significant.

Boys at grade two have a mean pitch in difficult reading of 257.0 cps. The mean for boys at grade six is 259.7 cps. The mean difference is 2.7 cps. The critical ratio is 1.58 and statistically insignificant.

Table 35 shows a comparison of the mean vocal pitches of boys in unaided recall of difficult reading at three grade levels.

TABLE 35

COMPARISON OF BOYS' VOCAL PITCH
IN UNAIDED RECALL OF DIFFICULT READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	29	254.1	6.65	1.26	.8	1.97	.45
4	31	254.9	8.35	1.52			
4	31	254.9	8.35	1.52	.3	1.9	.21
6	33	254.6	6.47	1.14			
2	29	254.1	6.65	1.26	.5	1.17	.29
6	33	254.6	6.47	1.14			

The mean pitch of boys' voices in unaided recall of difficult reading at grade two is 254.1 cps compared to a mean pitch of 254.9 cps at grade four for boys. The difference of the means is .8 cps. The critical ratio is .45 which is not significant.

The mean pitch of voice in unaided recall of difficult reading at grade four is 254.9 cps. The mean for boys in the same variable at grade six is 254.6 cps. The difference between the means is .3 cps. The critical ratio is .21 and not significant.

Boys at grade two have a mean pitch in unaided recall of difficult reading of 254.1 cps while boys at grade six have a mean of 254.6 cps. The difference in the means is .5 cps. The critical ratio is .29 which is low and insignificant.

No significant differences are found for boys' vocal pitches in any of the five variables at the three grade levels compared.

Comparison of mean vocal pitches for girls at three grade levels was made to disclose significant differences in fundamental frequencies used in each variable. Table 36 shows a comparison of mean vocal pitch for girls in speaking at three grade levels.

TABLE 36

COMPARISON OF GIRLS' VOCAL PITCH IN SPEAKING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	22	254.4	4.45	.97	2.9	1.53	1.80
4	21	251.5	5.29	1.18			
4	21	251.5	5.29	1.18	.3	1.49	.17
6	24	251.2	4.36	.91			
2	22	254.4	4.45	.97	3.1	1.33	2.36
6	24	251.2	4.36	.91			

Girls at grade two use a mean pitch of 254.4 cps in speaking while girls at grade four use a mean pitch of 251.5 cps. The mean difference is 2.9 cps. The critical ratio of 1.80 is not significant.

A mean speaking pitch for girls at grade four of 251.5 cps is .3 cps higher than 251.3 cps, the mean speaking pitch used by girls at grade six. The critical ratio is .17 and statistically insignificant.

The pitch of girls' voices in speaking at grade two is 254.4 cps which is 3.2 cps higher than the pitch of 251.2 cps used by girls at grade six. The critical ratio of 2.36 shows the difference to be significant and not due to chance factors.

Table 37 shows a comparison of mean pitches of girls' voices in easy reading at three grade levels.

TABLE 37

COMPARISON OF GIRLS' VOCAL PITCH IN EASY READING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	22	258.1	4.88	1.07	1.4	2.53	.53
4	21	259.5	10.23	2.29			
4	21	259.5	10.23	2.29	1.1	2.61	.41
6	24	258.4	6.00	1.25			
2	22	258.1	4.88	1.07	.3	1.64	.07
6	24	258.4	6.00	1.25			

The mean pitch of girls' voices in easy reading is 258.1 cps at grade two. At grade four the mean pitch is 259.5 cps. The mean difference is 1.4 cps. The critical ratio is .53 which is not significant.

In easy reading at grade four girls have a mean pitch of 259.5 cps which is 1.1 cps above that of 258.4 cps for girls at grade six. The critical ratio is .41 and not significant.

The mean pitch of girls' voices in easy reading at grade two is 258.1 cps compared to a mean pitch of 258.4 cps for girls at grade six. The difference of the means is .3 cps. The critical ratio is .07 which is insignificant.

Table 38 shows a comparison of pitch of voice for girls in unaided recall of easy reading at three grade levels.

TABLE 38

COMPARISON OF GIRLS' VOCAL PITCH
IN UNAIDED RECALL OF EASY READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	22	255.3	4.24	.93	3.8	1.94	1.96
4	21	251.5	7.61	1.07			
4	21	251.5	7.61	1.07	2.5	2.10	1.18
6	24	254.0	5.97	1.24			
2	22	255.3	4.24	.93	1.3	1.55	.83
6	24	254.0	5.97	1.24			

The mean pitch of voice in unaided recall of easy reading for girls at grade two is 255.3 cps. The mean pitch of voice in the same variable for girls at grade four is 251.5 cps. The mean difference is 3.8 cps. The critical ratio is 1.96 which is not significant.

Girls at grade four have a mean pitch in unaided recall of easy reading of 251.5 cps while girls at grade six have a mean pitch in unaided recall of 254.0 cps. The differences of the means is 2.5 cps. The critical ratio is 1.18 which is not significant.

The mean pitch used in unaided recall of easy reading by girls in grade two is 255.3 cps. The mean pitch used in the same variable in grade six is 254.0 cps. The mean difference is 1.3 cps. The critical ratio is .83 and not significant.

Table 39 shows a comparison of mean pitches in difficult reading for girls at three grade levels.

TABLE 39

COMPARISON OF GIRLS' VOCAL PITCH IN DIFFICULT READING AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	22	258.3	4.73	1.03	.3	2.68	.13
4	21	258.0	11.02	2.47			
4	21	258.0	11.02	2.47	.6	3.00	.21
6	24	258.6	8.14	1.70			
2	22	258.3	4.73	1.03	.3	1.99	.14
6	24	258.6	8.14	1.70			

The mean pitch of voice for girls in difficult reading is 258.3 cps at grade two. The mean pitch for girls in difficult reading at grade four is 258.0 cps. The mean difference is .3 cps. The critical ratio is .13 which is low and insignificant.

Difficult reading pitch for girls at grade four is 258.0 cps which is .6 cps lower than difficult reading pitch of 258.6 cps used by girls at grade six. The critical ratio is .21 and insignificant.

The mean vocal pitch for girls at grade two in difficult reading is 258.3 cps. This is .3 cps lower than 258.6 cps, the mean pitch used by girls at grade six. The critical ratio is .14 and not significant.

Table 40 shows a comparison of mean pitches of girls in unaided recall of difficult reading at three grade levels.

TABLE 40

COMPARISON OF GIRLS' VOCAL PITCHES
IN UNAIDED RECALL OF DIFFICULT READING
AT GRADES TWO, FOUR, AND SIX

Grade	No.	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
2	22	255.3	4.23	.92	1.0	2.1	.48
4	21	254.3	8.45	1.89			
4	21	254.3	8.45	1.89	.6	2.23	.26
6	24	253.7	5.69	1.19			
2	22	255.3	4.23	.92	1.6	1.50	1.05
6	24	253.7	5.69	1.19			

Girls' mean pitch in unaided recall of difficult reading at grade two is 255.3 cps. At grade four in the same variable it is 254.3 cps. The mean difference is 1.0 cps. The critical ratio is .48 and not significant.

The mean pitch of voice in unaided recall of difficult reading is 254.3 cps for grade four girls and 253.7 cps for grade six girls. The mean difference is .6 cps. The critical ratio of .26 is not significant.

Unaided recall of difficult reading pitch for girls at grade two is 255.3 cps which is 1.6 cps higher than a mean pitch in the same variable of 253.7 cps for girls at grade six. The critical ratio is 1.05 and not significant.

In the comparison of girls' mean pitches at three grade levels, the only significant difference revealed is between speaking pitches at grades two and six.

Vocal pitch related to different levels of intelligence.-- The groups used for the study of the relationship of vocal pitch to intelligence were selected from the lower and upper thirds of the population grouped at three grade levels according to I.Q. scores as described on page 60. Pitch data were compared in five variables to determine if significant pitch differences exist between groups with differing levels of intelligence. Table 41 shows the range and distribution of mean vocal pitches for lower and upper thirds of the second grade population grouped for intelligence.

TABLE 41

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE TWO

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
271-273			1	2						
268-270		1	0	0		1	2		1	
265-267		0	1	3	1	1	0	1	0	1
262-264	1	2	1	1	1	0	3	3	0	0
259-261	2	5	3	2	3	6	3	4	2	4
256-258	3	3	3	2	0	0	4	3	3	3
253-255	3	0	5	4	4	3	2	3	3	4
250-252	5	2	1	2	6	3	0	1	4	0
247-249	1	4	2	0	1	2	2	1	3	4
244-246	1			1	1	0	1	0	1	1
241-243	1					1		1		
Lower Third (N 17)										
Mean (cps)	252.9		256.8		254.3		257.6		253.9	
S.D.	7.54		5.79		5.41		6.16		5.84	
Range (cps)	242.0-263.8		248.6-272.5		246.0-265.4		245.0-269.3		246.0-270.0	
Upper Third (N 17)										
Mean (cps)	256.6		258.9		255.4		256.9		254.7	
S.D.	5.97		7.45		6.45		5.69		5.65	
Range (cps)	249.0-268.0		246.3-273.3		242.3-266.0		241.7-265.7		244.0-265.0	

Table 41 shows that the upper and lower intelligence groups at grade two have similar mean pitch ranges in all variables compared. Speaking, with a standard deviation of 7.54, has the greatest variability of mean pitch range for the lower intelligence group. Easy reading with a standard deviation of 7.45, shows the greatest variability for the upper intelligence group.

Table 42 shows a comparison of mean vocal pitch in the five variables for lower and upper intelligence groups of second grade pupils.

TABLE 42

COMPARISON OF VOCAL PITCH IN FIVE ORAL ACTIVITIES BETWEEN LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE TWO

Variable	I.Q. Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Lower Third	252.9	7.54	1.88	3.7	2.40	1.53
	Upper Third	256.6	5.97	1.49			
Easy Reading	Lower Third	256.8	5.79	1.45	2.1	2.36	.85
	Upper Third	258.9	7.45	1.86			
Unaided Recall of Easy Reading	Lower Third	254.3	5.41	1.35	1.1	2.1	.54
	Upper Third	255.4	6.45	1.61			
Difficult Reading	Lower Third	257.6	6.16	1.54	.7	2.09	.33
	Upper Third	256.9	5.69	1.42			
Unaided Recall of Difficult Reading	Lower Third	253.9	5.84	1.46	.8	2.03	.40
	Upper Third	254.7	5.65	1.41			

Table 42 reveals that the mean speaking pitch for the lower I.Q. group at grade two is 252.9 cps compared to 256.6 cps for the upper group.

The mean difference is 3.7 cps. The critical ratio is 1.53 and not significant.

The lower I.Q. group at grade two has a mean easy reading pitch of 256.8 cps. The upper group has a mean pitch of 258.9 cps. The mean difference is 2.1 cps. The critical ratio of this difference is .85 and not statistically significant.

In unaided recall of easy reading at grade two the lower intelligence group has a mean pitch of 254.3 cps which is 1.1 cps below the upper group's mean of 255.4 cps. The critical ratio is .54 and not significant.

The mean pitch for the lower I.Q. group in difficult reading is 257.6 cps. The mean pitch for the upper I.Q. group is 256.9 cps. The mean difference is .7 cps. The critical ratio is .33 and not significant.

In unaided recall of difficult reading at grade two, the lower intelligence group has a mean pitch of 253.9 cps and the upper intelligence group has a mean of 254.7 cps. The mean difference is .8 cps. The critical ratio is .40 which is low and statistically insignificant.

No significant vocal pitch differences appear between lower and upper thirds of the second grade population grouped according to intelligence.

Table 43 shows the range and distribution of mean vocal pitches of lower and upper thirds of the fourth grade population grouped for intelligence.

TABLE 43

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE FOUR

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
280-282			1				1			
277-279			0				0			
274-276			0				1			
271-273			0				0		1	
268-270			2	1			2	3	0	
265-267			2	0	2	1	1	2	0	2
262-264	1		2	0	1	2	0	5	2	2
259-261	4	1	2	2	1	1	3	2	1	3
256-258	1	4	4	3	3	4	4	0	6	1
253-255	2	4	1	2	2	3	1	1	1	4
250-252	4	3	1	5	2	4	1	1	2	0
247-249	3	1	0	2	2	0	1	0	1	3
244-246	0	4	0	0	1	0	0	2	1	1
241-243	0		0	0	1	1	0	0	0	0
238-240	1		0	0	0	0	0	1	1	1
235-237	0		0	0	1	1	2		1	
232-234	0		1	1	1					
229-231	1		1	1						
Lower Third--N 17										
Mean (cps)	251.8		258.8		252.5		258.3		254.4	
S.D.	7.71		6.90		8.84		11.69		8.29	
Range (cps)	231.3-262.1[illegible]		229.0-280.8		234.0-267.3		235.3-282.0		237.0-271.7	
Upper Third--N 17										
Mean (cps)	252.3		262.4		254.2		259.3		255.0	
S.D.	4.68		10.04		7.31		9.21		7.67	
Range (cps)	244.8-260.7		242.7-278.8		236.7-266.7		240.0-270.0		239.4-266.4	

Table 43 shows that the standard deviations are dissimilar for vocal pitch ranges of the two intelligence groups at grade four. Greatest variability of mean pitch is shown in difficult reading for the lower I.Q. group and in easy reading for the upper I.Q. group. Least variability is noted in easy reading for the lower I.Q. group and in speaking for the upper I.Q. group.

The upper intelligence group has the narrower range total and the higher mean pitch in every variable.

Table 44 shows a comparison of mean pitches in the five variables for groups of lower and upper intelligence at grade four.

TABLE 44

COMPARISON OF VOCAL PITCH IN FIVE ORAL ACTIVITIES
BETWEEN LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE FOUR

Variable	I.Q. Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Lower Third	251.8	7.71	1.93	.5	2.26	.23
	Upper Third	252.3	4.68	1.17			
Easy Reading	Lower Third	258.8	6.90	1.72	3.6	3.04	1.21
	Upper Third	262.4	10.04	2.51			
Unaided Recall of Easy Reading	Lower Third	252.5	8.84	2.21	1.7	2.87	.61
	Upper Third	254.2	7.31	1.83			

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TABLE 44 (concluded)

Variable	I.Q. Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Difficult Reading	Lower Third	258.3	11.69	2.92	1.0	3.71	.29
	Upper Third	259.3	9.21	2.30			
Unaided Recall of Difficult-Reading	Lower Third	254.4	8.29	2.07	.6	2.82	.22
	Upper Third	255.0	7.67	1.92			

The mean speaking pitch for the lower I.Q. group at grade four is shown in Table 44 to be 251.8 cps compared to 252.3 cps for the upper I.Q. group. The lower group has a mean speaking pitch .5 cps below the upper intelligence group. The critical ratio of the difference is .23 which is not significant.

The lower I.Q. group has a mean easy reading pitch of 258.8 cps at grade four. The upper group has a mean of 262.4 cps. The mean difference is 3.6 cps. The critical ratio of this difference is 1.21 and is not statistically significant.

In unaided recall of easy reading at grade four, the lower intelligence third has a mean pitch of 252.5 cps which is 1.7 cps below the upper third's mean of 254.2 cps. The critical ratio is .61 which is not significant.

The mean pitch for the fourth grade lower I.Q. group in difficult reading is 258.3 cps. The mean for the upper I.Q. group is 259.3 cps.

The mean difference is 1.0 cps. The critical ratio is .29 and not statistically significant.

In unaided recall of difficult reading, the lower third has a mean pitch of 254.4 cps and the upper third has a mean pitch of 255.0 cps. The mean difference is .6 cps. The critical ratio is .22 and not significant.

No significant differences are shown in the comparisons of mean vocal pitch of lower and upper intelligence groups in five oral activities at the fourth-grade level.

Table 45 shows the range and distribution of mean pitches in five oral activities for lower and upper thirds in intelligence at grade six.

TABLE 45

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE SIX

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
283-285							1			
280-282							0			
277-279							0			
274-276							0			
271-273				1			0	1	1	
268-270			1	0			0	2	0	
265-267			2	4	1	2	2	2	1	
262-264			2	2	1	1	4	2	1	2
259-261	3	1	7	7	4	2	3	7	2	0
256-258	3	3	0	3	1	1	3	1	2	2
253-255	2	3	4	0	3	8	2	2	1	8
250-252	8	10	0	2	7	5	2	2	6	2
247-249	0	1	1		0		1	0	2	5
244-246	1	1	1		1		1		0	
241-243	1		0		0				2	
238-240	1		1		1				1	
Lower Third--N 19										
Mean (cps)	251.3		257.8		254.2		258.9		253.4	
S.D.	5.70		7.54		6.38		8.14		7.89	
Range (cps)	238.6-260.0		239.0-269.4		240.0-265.5		244.2-282.7		240.0-271.7	
Upper Third--N 19										
Mean (cps)	252.1		261.2		255.5		260.4		253.7	
S.D.	3.32		5.07		4.89		5.69		4.30	
Range (cps)	248.0-260.4		251.8-267.1		250.0-265.0		250.0-272.0		248.2-263.6	

Table 45 shows that the range of mean pitch for the upper I.Q. group at grade six is smaller than for the lower I.Q. group in every variable compared.

Means of vocal pitch are slightly higher in all oral activities for the upper I.Q. group but the differences are not statistically significant. The standard deviations are larger for the lower I.Q. group which indicates greater variability in the distribution of mean pitches in all variables for that group.

While the range in difficult reading for the lower group appears to have the greatest range, closer inspection discloses that one extremely high mean pitch is responsible for the unusually large range and, consequently, the largest standard deviation.

Table 46 shows a comparison of mean pitches in five variables for groups of lower and upper intelligence at grade six.

TABLE 46

COMPARISON OF VOCAL PITCH IN FIVE ORAL ACTIVITES BETWEEN LOWER AND UPPER THIRDS IN INTELLIGENCE AT GRADE SIX

Variable	I.Q. Group (N 19)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$	$S.E._d$	C.R.
Speaking	Lower Third	251.3	5.70	1.34	.8	1.90	.38
	Upper Third	252.1	3.32	.78			
Easy Reading	Lower Third	257.8	7.54	1.78	3.4	2.15	1.58
	Upper Third	261.2	5.07	1.20			

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TABLE 46 (concluded)

Variable	I.Q. Group (N 19)	Mean (cps)	S.D.	S.E.$_m$	Diff.$_m$ (cps)	S.E.$_d$	C.R.
Unaided Recall of Easy Reading	Lower Third	254.2	6.38	1.50	1.3	1.89	.68
	Upper Third	255.5	4.89	1.15			
Difficult Reading	Lower Third	258.9	8.14	1.92	1.5	2.34	.64
	Upper Third	260.4	5.69	1.34			
Unaided Recall of Difficult Reading	Lower Third	253.4	7.89	1.86	.3	2.12	.12
	Upper Third	253.7	4.30	1.01			

The mean speaking pitch at grade six is shown to be 251.3 cps for the lower I.Q. group compared with 252.1 cps for the upper group. The lower third has a mean speaking pitch .8 cps below the upper third. The critical ratio for this difference is .38 which is not significant.

The lower I.Q. group has a mean easy reading pitch of 257.8 cps at grade six. The upper group has a mean of 261.2 cps. The mean difference is 3.4 cps. The critical ratio of this difference is 1.58 and is not statistically significant.

The mean pitch in unaided recall of easy reading for the lower I.Q. third at grade six is 254.2 cps which is 1.3 cps below the upper third's mean pitch of 255.5 cps. The critical ratio is .68 and not significant.

The mean pitch for the lower I.Q. group in difficult reading at grade six is 258.9 cps. The mean for the upper I.Q. group is 260.4 cps. The mean difference is 1.5 cps. The critical ratio is .64 and not significant.

In unaided recall of difficult reading, the lower I.Q. group has a mean pitch of 253.4 cps. The upper I.Q. group has a mean of 253.7 cps. The mean difference is .3 cps. The critical ratio is .12 and not significant.

No significant pitch differences are disclosed by the comparisons of lower and upper thirds of the population grouped according to intelligence at three grade levels.

Vocal pitch related to differing levels of educational achievement.-- Groups used for the study of the relationship of pitch of voice to educational achievement were selected from the lower and upper thirds of the population grouped at three grade levels according to educational achievement grade equivalent scores as described on page 60. The pitch data were compared in five variables to determine if significant pitch differences exist between groups with differing levels of achievement. Table 47 shows the range and distribution of mean pitches for lower and upper thirds of the second grade population grouped for educational achievement.

TABLE 47

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN EDUCATIONAL ACHIEVEMENT AT GRADE TWO

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
271-273			2	1						
268-270	1		0	0			1		1	
265-267	0		3	2	1	2	2	3	0	
262-264	4		0	0	0	0	1	1	0	1
259-261	3	3	2	2	3	4	5	2	2	4
256-258	4	1	2	4	1	0	3	3	5	1
253-255	2	4	6	4	5	3	2	3	3	1
250-252	1	4	1	3	3	6	1	2	4	4
247-249	2	3	0	1	3	1	2	3	1	5
244-246		0	1		0	1			1	0
241-243		2			1					0
238-240					0					1
Lower Third--N 17										
Mean (cps)	257.7		258.6		253.8		258.1		255.1	
S.D.	5.84		7.32		5.47		5.68		5.44	
Range (cps)	246.7-268.0		245.5-273.3		242.3-265.4		248.4-269.3		246.0-270.0	
Upper Third--N 17										
Mean (cps)	252.3		257.0		254.7		256.4		252.5	
S.D.	5.18		5.95		5.71		5.87		6.05	
Range (cps)	242.0-261.3		249.2-270.8		246.4-266.0		246.7-267.1		239.1-262.5	

Table 47 shows that the variability of mean pitch, as indicated by the standard deviation, is similar for both lower and upper thirds in educational achievement at grade two excepting for easy reading which is more variable for the low achievers. There is no consistent pattern between the groups as shown by the range limits and means in each variable. The lower achievement group uses a mean vocal pitch higher than the upper achievement group excepting for unaided recall of easy reading.

Table 48 shows a comparison of mean vocal pitch in the five variables for lower and upper thirds in educational achievement at grade two.

TABLE 48

COMPARISON OF VOCAL PITCH IN FIVE ORAL ACTIVITIES
BETWEEN LOWER AND UPPER THIRDS IN ACHIEVEMENT AT GRADE TWO

Variable	Achievement Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Lower Third	257.7	5.84	1.46	5.4	1.95	2.75
	Upper Third	252.3	5.18	1.29			
Easy Reading	Lower Third	258.6	7.32	1.83	1.6	2.36	.69
	Upper Third	257.0	5.95	1.49			
Unaided Recall of Easy Reading	Lower Third	253.8	5.47	1.37	.9	2.37	.41
	Upper Third	254.7	5.71	1.93			
Difficult Reading	Lower Third	258.1	5.68	1.42	1.7	2.04	.84
	Upper Third	256.4	5.87	1.47			
Unaided Recall of Difficult Reading	Lower Third	255.1	5.44	1.36	2.6	2.03	1.26
	Upper Third	252.5	6.05	1.51			

Table 48 shows that the mean speaking pitch for the lower third of the grade two population grouped according to educational achievement is 257.7 cps compared to 252.3 cps for the upper third. The lower achievement group has a mean speaking pitch 5.4 cps higher than the upper group. The critical ratio is 2.75 which is significant.

The lower achievement group has a mean easy reading pitch of 258.6 cps. The upper achievement group has a mean pitch of 257.0 cps. The mean difference is 1.6 cps. The critical ratio of this difference is .69 and is not statistically significant.

In unaided recall of easy reading at grade two the lower achievement third has a mean pitch of 253.8 cps which is .9 cps below the upper third's mean of 254.7 cps. The critical ratio of .41 shows that this difference is low and insignificant.

The mean pitch for the lower achievement group at grade two in difficult reading is 258.1 cps. The mean pitch for the upper third is 256.4 cps. The mean difference is 1.7 cps. A critical ratio of .84 is low and not significant.

The lower achievement third has a mean pitch in unaided recall of difficult reading of 255.1 cps. The upper third has a mean of 252.5 cps. The mean difference is 2.6 cps. The critical ratio of 1.26 is not significant.

At the grade two level the only significant difference disclosed by this comparison of mean pitch for lower and upper thirds of educational achievement occurs in speaking.

Table 49 shows the range and distribution of mean vocal pitch of lower and upper thirds of the fourth grade population grouped according to educational achievement.

TABLE 49

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN EDUCATIONAL ACHIEVEMENT AT GRADE FOUR

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
280-282							1			
277-279				2			0			
274-276			2	0			0			
271-273			1	2			0		2	
268-270			1	1			2	2	0	
265-267	1		4	1	1	2	3	4	0	
262-264	2	1	3	2	5	2	3	2	2	4
259-261	3	1	3	1	2	1	4	4	3	1
256-258	3	3	1	1	3	1	1	0	6	2
253-255	3	2	1	4	3	2	1	1	0	3
250-252	4	2	0	0	1	5	0	1	2	1
247-249	0	3	1	1	2	0	1	1	0	3
244-246	0	5		1		2	1	1	1	2
241-243	1			1		1		0	0	0
238-240						0		1	1	1
235-237						1				

	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
Lower Third--N 17					
Mean (cps)	256.6	263.7	257.6	263.4	257.6
S.D.	6.50	6.84	5.58	7.04	7.77
Range (cps)	243.2-266.8	247.3-274.0	246.7-267.0	248.3-282.0	240.0-272.0
Upper Third--N 17					
Mean (cps)	251.5	260.5	253.1	257.7	253.1
S.D.	5.52	10.46	8.25	8.94	6.93
Range (cps)	244.8-262.7	242.7-278.8	236.7-266.7	240.0-270.0	239.4-262.0

The upper third in educational achievement at grade four shows greater variability of mean vocal pitch than the lower third in all but speaking and unaided recall of difficult reading. Table 49 also shows that the lower achievement group has more variability of mean pitch in unaided recall of difficult reading than in the other variables. The lower achievement group has higher means in each variable than the upper third of the grade four population grouped according to educational achievement.

Table 50 gives a comparison of mean pitches in the five oral activities for the lower and upper thirds of the population in educational achievement at grade four.

TABLE 50

COMPARISON OF VOCAL PITCH IN FIVE ORAL ACTIVITIES BETWEEN LOWER AND UPPER THIRDS IN EDUCATIONAL ACHIEVEMENT AT GRADE FOUR

Variable	Educational Achievement Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Lower Third	256.6	6.50	1.62	5.1	2.13	2.36
	Upper Third	251.5	5.52	1.38			
Easy Reading	Lower Third	263.7	6.84	1.71	3.2	3.12	1.03
	Upper Third	260.5	10.46	2.61			
Unaided Recall of Easy Reading	Lower Third	257.6	5.58	1.39	4.5	2.48	1.79
	Upper Third	253.1	8.25	2.06			

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TABLE 50 (concluded)

Variable	Educational Achievement Group (N 17)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Difficult Reading	Lower Third	263.4	7.04	1.76	5.7	2.84	1.99
	Upper Third	257.7	8.94	2.23			
Unaided Recall of Difficult Reading	Lower Third	257.6	7.77	1.94	4.5	2.60	1.72
	Upper Third	253.1	6.93	1.73			

The mean speaking pitch for the lower educational achievement third of the fourth grade population is shown in Table 50 to be 256.6 cps compared to 251.5 cps for the upper third. The lower achievement group has a mean speaking pitch 5.1 cps above that of the upper group. The critical ratio is 2.36 which is significant.

The lower achievement third has a mean easy reading pitch of 263.7 cps at grade four. The upper third has a mean pitch of 260.5 cps. The mean difference is 3.2 cps. The critical ratio is not significant at 1.03.

In unaided recall of easy reading at grade four the lower achievement third has a mean pitch of 257.6 cps which is 4.5 cps higher than the upper third's mean of 253.1 cps. A critical ratio of 1.79 is not significant.

The lower third in educational achievement at grade four has a mean pitch in difficult reading of 263.4 cps. The upper third has a mean of 257.7 cps. The mean difference is 5.7 cps. The critical ratio of 1.99 is not significant.

The mean pitch for the lower achievement third at grade four in unaided recall of difficult reading is 257.6 cps which is 4.5 cps above that of the upper third whose mean is 253.1 cps. The critical ratio is 1.73 which is not significant.

In the comparisons made of mean vocal pitch between groups of lower and upper thirds in educational achievement at grade four, speaking is the only oral activity in which a true statistical difference appears.

Table 51 shows the range and distribution of mean vocal pitch of lower and upper thirds of the sixth grade population grouped according to educational achievement.

TABLE 51

FREQUENCY DISTRIBUTION OF MEAN VOCAL PITCHES
OF LOWER AND UPPER THIRDS IN EDUCATIONAL ACHIEVEMENTS AT GRADE SIX

Range and Fundamental Frequency (cps)	Speaking		Easy Reading		Unaided Recall of Easy Reading		Difficult Reading		Unaided Recall of Difficult Reading	
	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third	Lower Third	Upper Third
280-283							1			
277-279										
274-276										
271-273				1			0		1	
268-270			1	0			0	1	0	
265-267			1	3	1	1	2	2	1	
262-264			4	3	1	2	4	2	0	1
259-261	3	1	6	1	3	1	3	6	2	1
256-258	3	3	1	2	3	3	3	2	3	3
253-255	2	3	3	1	3	5	2	3	0	6
250-252	8	10	0	3	5	7	2	3	6	4
247-249	0	1	1		1		1		3	5
244-246	1	1	0		1		1		0	
241-243	1		0		0				2	
238-240	1		1		1				1	
Lower Third--N 19										
Mean (cps)	251.2		258.0		253.9		258.9		253.1	
S.D.	5.76		7.28		6.12		8.10		7.72	
Range (cps)	238.6-260.0		239.0-269.4		240.0-265.5		244.2-282.7		240.0-271.7	
Upper Third--N 19										
Mean (cps)	252.5		260.5		255.0		258.5		252.9	
S.D.	2.80		5.63		4.54		5.17		3.86	
Range (cps)	248.0-260.4		250.8-272.8		250.0-264.5		250.0-268.0		248.2-263.6	

The lower educational achievement third tends to have more variability of mean pitch than the upper achievement group, as shown in Table 51 by standard deviations which are larger than those of the upper group in every oral activity.

The narrowest range of mean pitch for the lower achievement third is used in speaking, while the widest range is used in unaided recall of difficult reading. The upper group uses the narrowest range of mean pitch for speaking and the widest range for easy reading.

Table 52 shows a comparison of mean pitches in the five oral activities for the lower and upper educational achievement groups at the sixth-grade level.

TABLE 52

COMPARISON OF VOCAL PITCH BETWEEN LOWER AND UPPER THIRDS IN EDUCATIONAL ACHIEVEMENT AT GRADE SIX

Variable	Educational Achievement Group (N 19)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Speaking	Lower Third	251.2	5.76	1.36	1.3	1.51	.84
	Upper Third	252.5	2.80	.66			
Easy Reading	Lower Third	258.0	7.28	1.72	2.5	2.17	1.16
	Upper Third	260.5	5.63	1.33			
Unaided Recall of Easy Reading	Lower Third	253.9	6.12	1.44	1.1	1.79	.62
	Upper Third	255.0	4.54	1.07			
Difficult Reading	Lower Third	258.9	8.10	1.91	.5	2.27	.21
	Upper Third	258.5	5.17	1.22			

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TABLE 52 (concluded)

Variable	Educational Achievement Group (N 19)	Mean (cps)	S.D.	$S.E._m$	$Diff._m$ (cps)	$S.E._d$	C.R.
Unaided Recall of Difficult Reading	Lower Third	253.1	7.72	1.82	.2	2.03	.09
	Upper Third	252.9	3.86	.91			

In Table 52 the mean speaking pitch for the lower achievement third of the sixth grade population is 251.2 cps compared to 252.5 cps for the upper third. The lower group has a mean speaking pitch 1.3 cps below that of the upper group. The critical ratio is .84 which is not significant.

The lower achievement third at grade six has a mean easy reading pitch of 258.0 cps. The upper achievement third has a mean pitch of 260.5 cps. The mean difference is 2.5 cps and the critical ratio of this difference is 1.16 which is not statistically significant.

In unaided recall of easy reading at grade six, the lower achievement group has a mean pitch of 253.9 cps which is 1.1 cps lower than the upper third's mean pitch of 255.0 cps. The critical ratio of this difference is .62 and not significant.

The lower third in educational achievement at grade six has a mean pitch in difficult reading of 258.9 cps. The upper third has a mean of 258.5 cps. The mean difference of .1 cps gives a critical ratio of .21 which is low and insignificant.

The mean vocal pitch for the lower achievement third at grade six in unaided recall of difficult reading is 253.1 cps. The mean is .2 cps above 252.9 cps, the mean pitch for the upper achievement third. The critical ratio is .09 which is statistically insignificant.

No true differences are shown between the mean vocal pitch for lower and upper thirds of the sixth grade population when grouped according to educational achievement scores.

The following table repeats information already given in preceding tables, but is placed in summary form for the convenience of the reader.

TABLE 53

SUMMARY OF MEAN FUNDAMENTAL FREQUENCIES (CPS) OF THE VOICE
IN CERTAIN ACTIVITIES AT GRADES TWO, FOUR, AND SIX

Group	Number	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
Grade Two	51	254.5	258.5	254.8	257.6	254.6
Boys	29	254.6	258.8	254.3	257.0	254.1
Girls	22	254.4	258.1	255.3	258.3	255.3
Intelligence						
Lower Third	17	252.9	256.8	254.3	257.6	253.9
Upper Third	17	256.6	258.9	255.4	256.9	254.7
Achievement						
Lower Third	17	257.7	258.6	253.8	258.1	255.1
Upper Third	17	252.3	257.0	254.7	256.4	252.5
Grade Four	52	252.6	260.6	254.6	258.8	254.7
Boys	31	253.4	261.3	256.6	259.3	254.9
Girls	21	251.5	259.5	251.5	258.0	254.3
Intelligence						
Lower Third	17	251.8	258.8	252.5	258.3	254.4
Upper Third	17	252.3	262.4	254.2	259.3	255.0
Achievement						
Lower Third	17	256.6	263.7	257.6	263.4	257.6
Upper Third	17	251.5	260.5	255.0	258.5	252.9

(concluded on next page)

TABLE 53 (concluded)

Group	Number	Speaking	Easy Reading	Unaided Recall of Easy Reading	Difficult Reading	Unaided Recall of Difficult Reading
Grade Six	57	252.0	259.5	253.1	259.3	254.2
Boys	33	252.6	260.4	255.8	259.7	254.6
Girls	24	251.2	258.4	254.0	258.6	253.7
Intelligence						
Lower Third	19	251.3	257.8	254.2	258.9	253.4
Upper Third	19	252.1	261.2	255.5	260.4	253.7
Achievement						
Lower Third	19	251.2	258.0	253.9	258.9	253.1
Upper Third	19	252.5	260.5	255.0	258.5	252.9

CHAPTER VI

SUMMARY

Recapitulation

The purpose of this study was to find out what a child does with his vocal pitch in certain speaking and reading activities. Data from objective pitch measurements were analyzed:

1. To locate average pitch levels used by children in conversational speaking, in easy and difficult reading, and in unaided recall of easy and difficult reading
2. To compare the mean vocal pitches of the five oral activities noted above
3. To report average pitch levels significantly related to differences in grade placement, sex, intelligence, and educational achievement.

The population of this study of vocal pitch was composed of 51 second-grade pupils, 52 fourth-grade pupils, and 57 sixth-grade pupils from eight classrooms. Educational achievement and intelligence tests were given to the children to secure information essential to grouping the pitch data for various analyses.

Five oral tasks: speaking, easy and difficult reading, and unaided recall of easy and difficult reading, were chosen for pitch analysis. Selected pictures and paragraphs from Gilmore's Oral Reading Test[1] were

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[1]Gilmore, loc. cit.

used to stimulate children to perform these oral tasks in such a way that normal vocal pitch could be recorded. The tapes containing the voices were processed by the Purdue pitch meter, a machine which detects sound waves, changes them so they may be counted, and records them on a milliammeter chart.

After the reliability of the pitch record and methods for scoring it had been determined, pitches were read from the chart and the resulting data were analyzed. The five per cent level of confidence, which means 95 chances in 100 of a true difference, was used as the criterion of significance for the vocal pitch findings reported below.

Findings

Some of the differences found between mean pitches used in certain activities in this study were expected inasmuch as teachers often have observed that an elementary school child's vocal pitch seems to raise during oral reading. Findings which have a bearing on this observation and other aspects of children's vocal pitches are presented here:

1. The mean vocal pitches in the five variables, including speaking, reading, and recall, are similar between grades excepting for a significant difference in speaking pitch between grades two and six. With a mean pitch of 254.5 cps, grade two has a speaking pitch which is 2.5 cps higher than grade six speaking pitch of 252.0 cps. A critical ratio of 2.55 establishes this as a true difference.
2. The easy reading mean pitch is found to be significantly higher than the speaking pitch at grades two, four, and six.

a. Grade two easy reading mean pitch of 258.5 cps is 4.0 cps higher than the speaking mean of 254.5 cps. The critical ratio for the mean difference is 3.23 which shows a true difference.

b. Grade four easy reading mean pitch of 260.6 cps is 8.0 cps above the mean speaking pitch of 252.6 cps. The critical ratio is 4.40 and highly significant.

c. Grade six easy reading mean pitch of 259.5 cps is 7.5 cps above the mean speaking pitch of 252.0 cps. The critical ratio of the difference is 7.19 which indicates a true statistical difference.

3. At grade six, the mean pitch in immediate unaided recall of easy reading is significantly higher than the conversational speaking pitch. There is a mean difference of 3.1 cps between the unaided recall of easy reading pitch of 255.1 cps and the speaking pitch of 252.0 cps. A critical ratio of 3.23 establishes this as a true difference. It appears from this evidence that there is an influential high-pitch carryover from easy reading to unaided recall of easy reading at grade six only.

4. The mean vocal pitches used in difficult reading at grades two, four, and six are significantly higher than the speaking pitches.

a. At grade two the difficult reading mean pitch of 257.6 cps is 3.1 cps above the mean speaking pitch of 254.5 cps.

The critical ratio for the difference is 2.60 which indicates significance.

b. At grade four, the mean difficult reading pitch of 258.8 cps is 6.2 cps above the speaking pitch of 252.6 cps. The critical ratio of the mean difference is 3.64 and statistically significant.

c. At grade six, the mean difficult reading pitch of 259.3 cps is 7.3 cps above the speaking pitch of 252.0 cps. The critical ratio is 4.28 which shows this to be a true difference.

Since both easy and difficult reading pitches are significantly higher than the speaking pitches, the factors which cause the raise in reading pitch are present regardless of the difficulty of the materials used in this study.

5. Following difficult reading at grade six, the mean pitch level for immediate unaided recall of difficult reading is significantly higher than the speaking pitch. There is a mean difference of 2.2 cps between the unaided recall of difficult reading pitch at 254.2 cps and the speaking pitch of 252.0 cps. A critical ratio of 2.22 establishes this as a true difference.

6. There is significant lowering of mean pitch from easy reading to immediate unaided recall of easy reading at grades two, four, and six.

a. At grade two, the unaided recall of easy reading pitch of

254.8 cps is 3.7 cps lower than the mean pitch of 258.5 cps in easy reading. The critical ratio for the difference is 2.98 which indicates a true difference.

b. At grade four, the unaided recall of easy reading pitch of 254.6 cps is 6.0 cps below the mean pitch of 260.6 cps in easy reading. The critical ratio for the mean difference is 3.10 and statistically significant.

c. At grade six, the unaided recall of easy reading pitch of 255.1 is 4.4 cps lower than the mean pitch of 259.5 cps in easy reading. The critical ratio is 3.86 which shows this to be a true difference.

7. Mean pitch in unaided recall of difficult reading is significantly lower than mean pitch in easy reading at grades two, four, and six.

   a. Grade two unaided recall of difficult reading mean pitch of 254.6 cps is 3.9 cps lower than the easy reading mean of 258.5 cps. The critical ratio for the mean difference is 3.11 which shows a true difference.

   b. Grade four unaided recall of difficult reading mean pitch of 254.7 cps is 5.9 cps lower than the easy reading mean of 260.6 cps. The critical ratio is 3.08 which establishes the difference as statistically significant.

   c. Grade six unaided recall of difficult reading mean of 254.2 cps is 5.3 cps below the easy reading mean of 259.5 cps. The critical ratio of 4.44 shows this to be a true difference.

8. Within grades two, four, and six there is significant raising of mean pitch from unaided recall of easy reading to difficult reading.
   a. Grade two difficult reading pitch mean of 257.6 cps is 2.8 cps higher than the unaided recall of easy reading pitch mean of 254.8 cps. The critical ratio of 2.40 shows this to be a true difference.
   b. Grade four difficult reading pitch mean of 258.8 cps is 4.2 cps higher than the unaided recall of easy reading pitch mean of 254.6 cps. The critical ratio of 2.31 shows this to be statistically significant.
   c. Grade six difficult reading pitch mean of 259.3 cps is 4.2 cps above the unaided recall of easy reading mean of 255.1 cps. The critical ratio of 3.36 establishes the difference as significant.
9. There is significant lowering of mean pitch from difficult reading to immediate unaided recall of difficult reading at grades two, four, and six.
   a. At grade two, the unaided recall of difficult reading pitch of 254.6 cps is 3.0 cps lower than the mean pitch of 257.6 cps in difficult reading. The critical ratio for this difference is 2.54 which shows this to be a true difference.
   b. At grade four, the unaided recall of difficult reading pitch of 254.7 cps is 4.1 cps lower than the mean pitch of 258.8 cps in difficult reading. The critical ratio for the mean difference is 2.27 and statistically significant.

c. At grade six, the unaided recall of difficult reading pitch of 254.2 cps is 5.1 cps lower than the mean pitch of 259.3 cps in difficult reading. The critical ratio for the mean difference is 3.95 which shows a true difference.

10. A study of sex differences in mean vocal pitch shows the fourth-grade boys' mean pitch in unaided recall of easy reading to be 256.6 cps which is 5.1 cps higher than the fourth-grade girls' mean of 251.5 cps. The critical ratio of 2.21 indicates a true statistical difference.

11. Second-grade girls' speaking mean pitch of 254.4 cps is 3.2 cps above 251.2 cps, the mean speaking pitch of sixth-grade girls. The critical ratio of 2.36 shows this to be a true difference. A highly tentative conclusion is that maturity factors may be effecting a lower pitch for sixth-grade girls.

12. A study of the lower and upper thirds of the population grouped according to educational achievement reveals that the lower third uses a significantly higher speaking pitch than the upper third at grades two and four.

    a. The lower achievement third at the second-grade level has a mean speaking pitch of 257.7 cps which is 5.4 cps higher than 252.3 cps, the pitch mean of the upper third. The critical ratio of 2.75 shows this to be a true difference.

    b. At grade four, the lower achievement third has a mean pitch of 256.6 cps in speaking which is 5.1 cps higher than the upper third's mean of 251.5 cps. The critical ratio is 2.36 and statistically significant.

13. From comparisons made in this study, no significant differences are found to exist in boys' mean vocal pitches between grades two, four, and six.
14. From comparisons made in this study, no significant differences are found to exist between mean vocal pitches used by pupils of low and high intelligence within grades two, four, and six.

Suggestions for Further Research

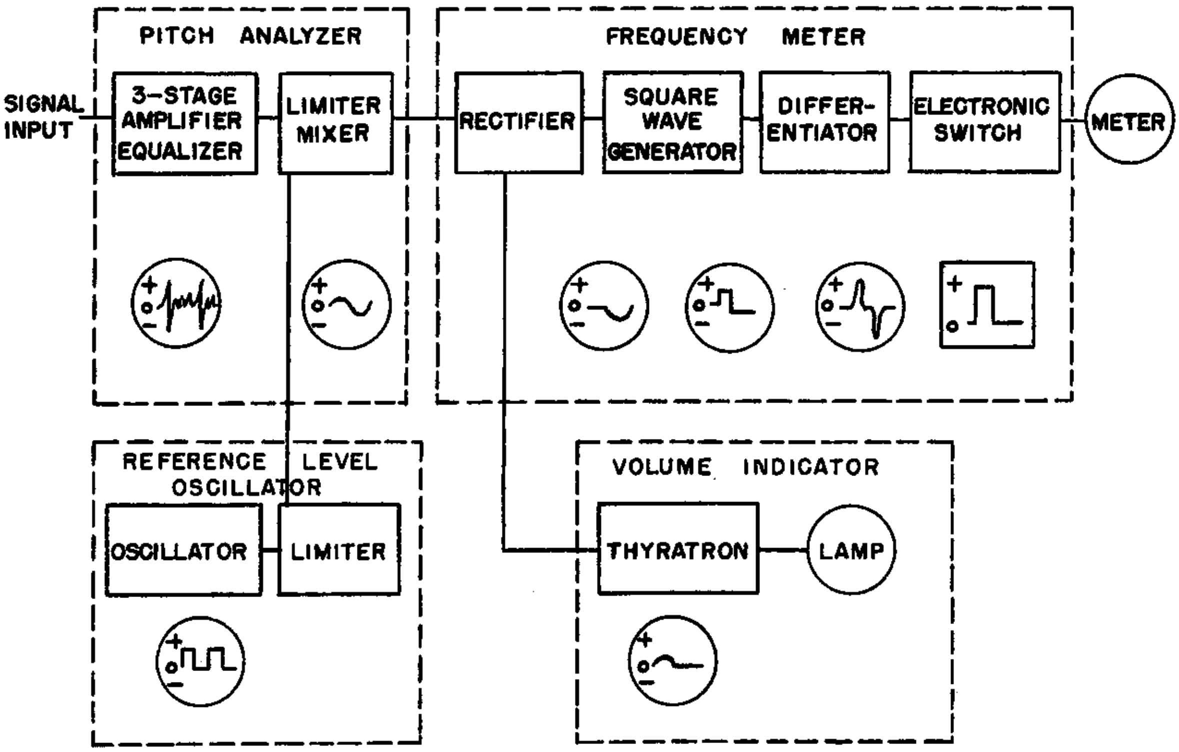
1. The same study repeated on different populations.
2. The same study repeated with variations in pitch meter technique and with later models of the pitch meter as they become available.
3. A follow-up study of the same population to learn, among other things, the direction and extent of pitch change in relation to maturity.
4. A pitch of voice study of kindergarten, first, third, and fifth-grade children.
5. Longitudinal studies of vocal pitch for large and small samples.
6. A study of reading and vocal pitch to determine causative factors in reading which might account for raising and lowering the vocal pitch.
7. Studies to investigate the causative factors of some of the other significant differences in pitch disclosed in the present research.

8. Study of the pitch used in both unaided and aided recall before and after instruction in recall has been given.
9. Studies of vocal pitch in oral activities other than those selected for this study, such as oral reports, play activities, both volunteered and "called-on" classroom recitation, discussion, debate, and others.
10. Study of the gross emotional states on vocal pitch of elementary children.
11. Pitch of voice of normal school children compared to hard-of-hearing children who attend school in the regular classroom.
12. A study to show the influence of pitch of voice in one oral activity on pitch of voice in the succeeding oral task.
13. A study of the teacher's vocal pitch as related to the speaking and working habits of pupils.
14. Studies of vocal pitch and attitude toward: (1) self, (2) teacher, (3) classmates, (4) a specific oral activity such as reading, (5) school.
15. A study of vocal pitch and children's audience reaction.

APPENDIX A

MATERIALS USED IN THE STUDY

Functional Block Diagram of the Purdue Pitch Meter[1]



[1]M. E. Dempsey and others, *op. cit.*, p. 136.

THE PURDUE PITCH METER CHART

The red line, indicating fundamental frequency of the voice, was drawn by the recording milliammeter in response to a signal from the Purdue pitch meter. The reference tone of 250 cps is shown on the right. Each small vertical section represents 10 cps. One horizontal section indicates four seconds of speaking time. Nonvocal portions of Sections 4, 5, and 10 have been canceled. Single and double bars mark the beginning and end of the speaking selection.

One reading of fundamental frequency was made for the first second of speaking time, right to left from the section dividing line to the dot, in each horizontal section.

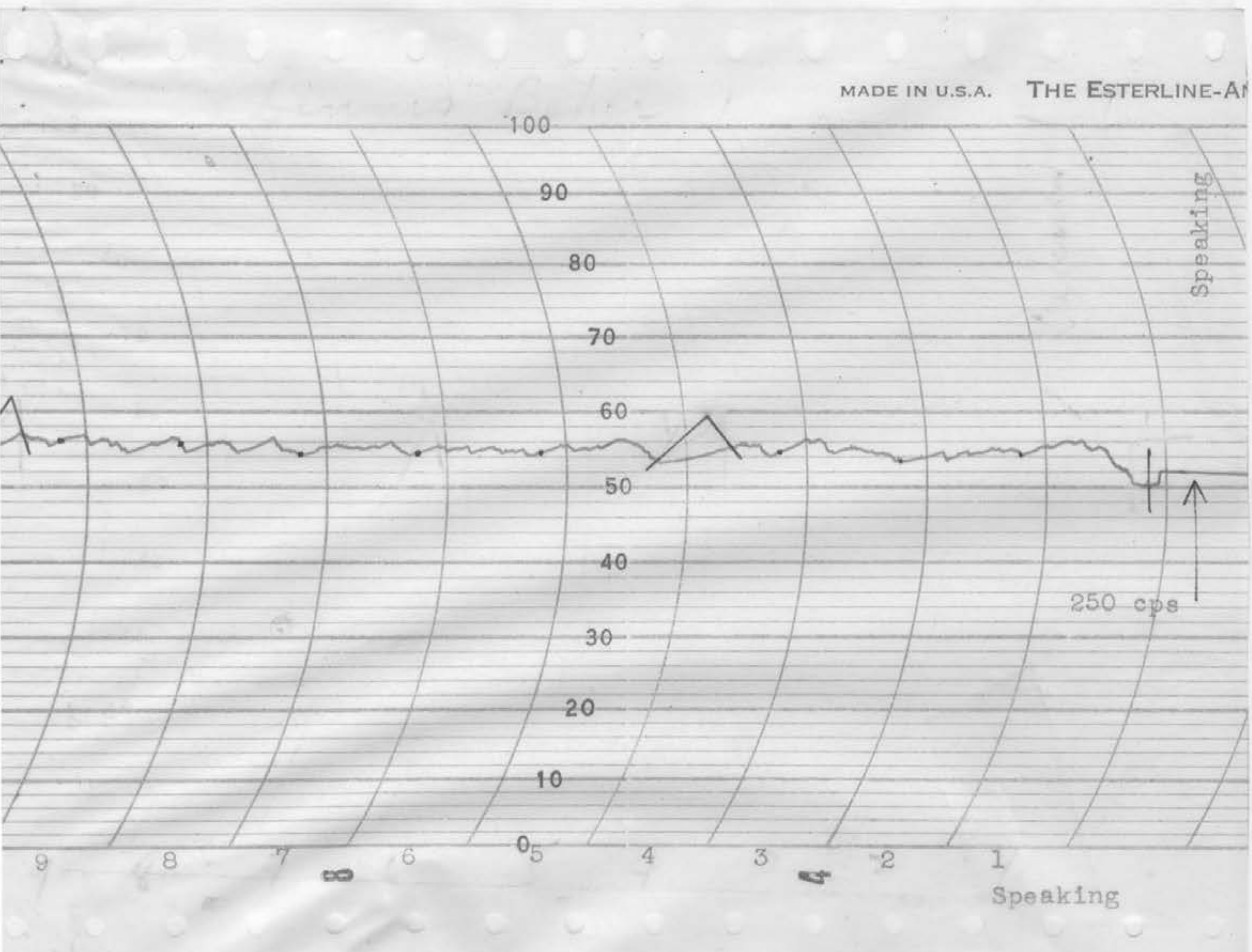


TABLE 54

FREQUENCIES OF MUSICAL TONES
(C_4 Middle C)

Musical Tone	Frequencies*							
	C_0-C_1**	C_1-C_2	C_2-C_3	C_3-C_4	C_4-C_5	C_5-C_6	C_6-C_7	C_7-C_8
C	16.36	32.70	65.40	130.8	261.6	523.2	1046.5	2093.0
C#	17.33	34.65	69.30	138.6	277.2	554.4	1108.7	2217.5
D	18.36	36.71	73.43	146.8	293.7	587.3	1174.7	2349.3
D#	19.44	38.88	77.76	155.6	311.1	622.3	1244.5	2489.0
E	20.60	41.20	82.40	164.8	329.6	659.3	1318.5	2637.0
F	21.84	43.68	87.35	174.6	349.2	698.5	1396.9	2793.9
F#	23.12	46.25	92.50	185.0	370.0	740.0	1480.0	2960.0
G	24.51	49.02	98.03	196.0	392.0	784.0	1568.0	3136.0
G#	25.96	51.91	103.8	207.7	415.3	830.6	1661.2	3322.4
A	27.50	55.00	110.0	220.0	440.0	880.0	1760.0	3520.0
A#	29.13	58.26	116.5	233.1	466.2	932.3	1864.7	3729.3
B	30.87	61.75	123.5	247.0	493.9	987.8	1975.5	3951.0
C	32.70	65.40	130.8	261.6	523.2	1046.5	2093.0	4186.0

* Cycles per second

** C-Scale Octave limits

PUPIL DATA SHEET

Tape: ____ ____ ________
roll side location

Code: _______ _____ ______ _____ ___
teacher grade number month day

Form ____ Paragraph: ____ ____
easy hard

Name______________________________

Sex: M F

Birthday _________________________
month day year

C.A. _______________________________
on day of recording

I.Q. _____________ Test ________

Date _______________________________
month year

Reading level _______ Test ______

Date _______________________________
month year

Achievement level _____ Test_____

Date _______________________________
month year

Foreign language background ____

OBSERVATIONS DURING TESTING

<u>Mannerisms</u>:

hands ( )
feet ( )
squirming ( )
frowning ( )
ducking head ( )
pointing ( )
clearing throat ( )
loses place ( )
holds book too close ( )

<u>Emotional reactions</u>:

fearful ( )
timid ( )
indifferent ( )
interested ( )
enthusiastic ( )
overconfident ( )

<u>Changes in voice from speaking to reading</u>:

Volume:

Duration:

Quality:

Articulation and Pronunciation:

Special Observations:

<u>Reading difficulties</u>:	Easy	Hard
word-by-word	( )	( )
words pronounced for child	( )	( )
mispronunciations	( )	( )
disregard of punctuation	( )	( )
insertions	( )	( )
substitutions	( )	( )
omissions	( )	( )

<u>Recall</u>:	Easy	Hard
formal style	( )	( )
informal style	( )	( )
good	( )	( )
fair	( )	( )
poor	( )	( )

ɜilmore Oral Reading Test FORM A

ʳ John V. Gilmore

ɔciate Professor of Psychology
ʲon University

RECORD BLANK

ME________________ DATE________________ GRADE____________

ɪOOL________________ AGE________ YEARS ________ MONTHS SEX____________

Y________________ STATE____________ EXAMINER____________

nmary Check List of Difficulties

m an analysis of the pupil's oral reading per-
nance, complete the check list below.

_ Many substitutions
_ Habitual mispronunciations
_ Many words pronounced by examiner
_ Habitual disregard of punctuation
_ Habitual insertions
_ Habitual hesitations
_ Habitual repetitions
_ Habitual omissions
_
_
_
_

ck the following immediately after completion
ɦe testing:

_ Word-by-word reading
_ Reads in monotone
_ Strained, high-pitched voice
_ Volume too loud
_ Volume too soft
_ Poor enunciation

ɪments:________________________

____

____

____

____

Test Summary

PARAGRAPH	ACCURACY		COMPREHENSION	RATE	
	ERRORS	10 MINUS NO. ERRORS	NO. RIGHT (OR CREDITED)	WORDS IN ¶	TIME IN SEC.
1				26	
2				50	
3				51	
4				68	
5				107	
6				107	
7				126	
8				147	
9				184	
10				252	
	ACC. SCORE (TOT. "10 MINUS NO. ERRORS" COLUMN)		COMP. SCORE (TOT. NO. RIGHT OR CREDITED)	(1) NO. WORDS READ*	
				(2) TIME IN SEC.*	
				(1) ÷ (2)	×60
GRADE EQUIV.				RATE SCORE (WPM)	
RATING					

*Do *not* count "ceiling" paragraph or paragraphs below "basal."

Silent Reading Test Data DATE__________

TEST____________________

WORD MEAN. (VOCAB.) GRADE EQUIV.__________

PARA. MEAN. (READ.) GRADE EQUIV.__________

AVE. READ. GRADE EQUIV.__________

Published 1952 by World Book Company, Yonkers-on-Hudson, New York, and Chicago, Illinois

a

PRINTED IN U.S.A. G : ORT : RB : A-4

1. I see a boy.
He has a dog.
Here is a girl.
I see a cat, too.
The man is Father.
Mother is in the house.

TIME ____Seconds

___1. What animal is the boy playing with?
___2. What other animal is there?
___3. Who is the man?
___4. Where is Mother?
___5. Whom else do you see?

NUMBER RIGHT ____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

2. The girl is in the yard.
The girl has a big ball.
The boy is back of the girl.
He is playing with his dog.
The cat looks at the girl.
He wants to play ball, too.
The girl does not see the cat.
She is looking at the ball.

TIME ____Seconds

___1. Where is the girl?
___2. What does the girl have?
___3. What is the boy doing?
___4. What does the cat want?
___5. What is the girl looking at?

NUMBER RIGHT ____

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

5. Every morning Father goes to his office by train. He usually leaves the house about eight o'clock. In rainy weather Mother drives him to the station. When the train reaches the city at eight forty-five, Father goes to the general offices of his company. An elevator carries him to the eleventh floor. His important position takes hours of extra time, and many evenings he doesn't arrive home until late. Bob and Jane are disappointed when he works at night, for he frequently assists them with their lessons. Then, too, if there is time after dinner for games, he often plays with them before they begin to study.

TIME ____Seconds

___1. What time does Father leave the house in the morning?
___2. What does Mother do for Father when it is raining?
___3. On what floor is Father's office?
___4. How does Father help Bob and Jane when he is home evenings?
___5. When does Father play games with them?

NUMBER RIGHT ____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

6. Nearly every family living in the city suburbs ta vacation sometime during the summer. When the we becomes warm, usually during July, Bob and Jane accom their parents to the seaside. In order to reach their de tion on the shore, they are obliged to travel over a mou range. If they begin their journey before sunrise the day, they can see many impressive scenes in the moun The exciting but lengthy trip requires two full days. at the beach Bob and Jane spend many blissful hours ba in the surf and relaxing on the sunny sand. Summer vac help Bob and Jane keep healthy.

TIME ____Seconds

___1. What does almost every city family do in summer?
___2. What month do Bob and Jane usually go to the sea with their parents?
___3. What must they do to reach the shore?
___4. How long is their trip?
___5. How do summer vacations help Bob and Jane?

NUMBER RIGHT ____

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

3. The name of the boy is Bob.
The name of his sister is Jane.
They live with their parents
in a white house near the city.
They are playing on the walk.
The dog and cat are their pets.
After Father has gone to work,
the children will leave for school.

IE ______Seconds

What is the boy's name?
What is his sister's name?
Where is their house?
What are their pets?
When will the children leave for school?

MBER RIGHT ______

ERROR RECORD	Number
itutions	
onunciations	
s pronounced by examiner	
gard of punctuation	
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itions	
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otal Errors	

4. Mother waves good-by to Father each morning. She begins the housework soon after he leaves. Bob and Jane help her before they go to school. They dry the dishes and clean their own rooms. After Mother has finished the work indoors, she goes out to her pretty flower garden. She tends it nearly every day for about an hour. Mother does all her work with great care.

TIME ______Seconds

___1. What does Mother do as Father is leaving?
___2. What does Mother do after Father has gone?
___3. When do Bob and Jane help Mother?
___4. Where does Mother go after she has finished the work indoors?
___5. How long does she work in her garden each day?

NUMBER RIGHT ______

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

fter their restful and refreshing vacation is over, Bob ane feel quite adequately prepared for school. When eturn from their sojourn at the seashore, they are over- to play with their pets once again. Their parents are ted to see them tanned and healthy. School opens a few weeks after they return home, and during August nother helps them acquire the new clothing and equip- which they will need later. Each year the beginning of in early September brings a stimulating program of challenging studies. Bob's favorite subject will un- edly be sixth-grade science, while Jane, entering the grade, will enjoy reading. In addition to schoolwork, will take music lessons. Jane studies the violin, but refers the trumpet.

IE ______Seconds

What do Bob and Jane play with when they return from their vacation?
In what month does their mother help them buy their clothing and school equipment?
What grade will Bob be in?
What subject will Jane like?
What musical instrument does Bob play?

MBER RIGHT ______

ERROR RECORD	Number
itutions	
onunciations	
s pronounced by examiner	
gard of punctuation	
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itions	
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otal Errors	

8. Mother and Father are proudly making ambitious plans for the future education of their children, Bob and Jane. They realize that several factors are going to play a part in the ultimate selection of their careers. First of all, the children must be physically and mentally equipped for the professions of their choice. The financial cost of the necessary training program must also be considered, while a third factor is the attitude of relatives and friends. Obviously, Bob and Jane are not yet able to make a final choice. Parents often entertain secret ambitions for their children, and Mother and Father hope that Bob and Jane will enter some branch of medicine. They visualize Bob in surgery; however, at present he is fascinated by aviation. Although Jane has always aspired to be a kindergarten teacher, her family thinks that she is ideally suited for the nursing profession.

TIME ______Seconds

___1. What are Mother and Father planning for?
___2. What profession do they hope Bob and Jane will choose?
___3. What branch of this profession would they like Bob to enter?
___4. What interests Bob at the present time?
___5. What has Jane always wanted to be?

NUMBER RIGHT ______

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

9. Although Bob and Jane now think they will eventually comply with their parents' wishes in choosing medicine as their profession, a recent school incident indicates that their interests may later turn more in the direction of an intensive study of the human mind. One day, while discussing with their science instructor the differences between human beings and animals, they discovered that human mentality differs chiefly from animal mentality in being essentially preoccupied with symbols. They realized, for the first time, that they themselves were employing symbols. They learned that a symbol is a sign or word which refers to something, such as an object, a person, or a concept, and that nearly all knowledge is a product of symbolic expression. They discovered that symbols are used in languages, mathematics, and music; and they learned that even the flag is a symbolic emblem of patriotism. Thus, Bob and Jane are beginning to realize that the mind of man, which deals pre-eminently with these symbols, is a significant study in itself. They recognize the truth inherent in the adage, "The proper study of mankind is man."

TIME _____Seconds

__1. What study may later become of absorbing interest to Bob and Jane?
__2. With whom were Bob and Jane talking when they were comparing human beings and animals?
__3. How does the human mind differ from that of an animal?
__4. What emblem signifies love of country?
__5. What is the saying of which Bob and Jane now recognize the truth?

NUMBER RIGHT _____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

10. When Bob and Jane study psychology in college, will further penetrate the intricacies of the human Learning that the mind and the emotions are closely related, they will discover that virtually all problems cause disturbance to an individual are associated in some d with his emotional life. A person's "emotional adjustn not only affects his own happiness and equilibrium, bu has a profound influence on his associates; thus it is axio that emotions are a fundamental consideration in all h relationships. Psychology has proved conclusively that mony or discord among persons, far from occurring f tously, can be explained by the same principle of caus effect which operates in other fields of science. There a to be two general causes of group tensions: the first is g in character; and the second, related to the cultural mili which we live. Scholars in various areas of study, a whom we find anthropologists, sociologists, and statisti have joined the psychologist in assiduous investigatio this complex field. The problems of human relations confront our present-day society are both baffling and lenging; as intelligent citizens we can and should contrib their ultimate solution by trying conscientiously to under our own behavior. Such injunctions as "Don't take yo too seriously" have in the past been fashionable attem disposing of personal problems. However, they are more than avoidance mechanisms which ignore the real c of behavior; in light of current psychology they may i be considered anachronistic.

TIME _____Seconds

__1. In what college course will Bob and Jane study the mind?
__2. What factor affects the happiness of every individu
__3. According to modern psychology, what scientific pri explains relationships among people?
__4. Name one field besides psychology in which schola studying the problems of human relations.
__5. What can each individual do to help in the soluti these problems?

NUMBER RIGHT _____

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

ɜilmore Oral Reading Test FORM **B**

John V. Gilmore

ciate Professor of Psychology
on University

RECORD BLANK

ɪE______ DATE______ GRADE______

OOL______ AGE______ YEARS ______ MONTHS SEX______

______ STATE______ EXAMINER______

ımary Check List of Difficulties

n an analysis of the pupil's oral reading per-
ıance, complete the check list below.

_ Many substitutions
_ Habitual mispronunciations
_ Many words pronounced by examiner
_ Habitual disregard of punctuation
_ Habitual insertions
_ Habitual hesitations
_ Habitual repetitions
_ Habitual omissions
_
_
_
_

:k the following immediately after completion
ıe testing:

_ Word-by-word reading
_ Reads in monotone
_ Strained, high-pitched voice
_ Volume too loud
_ Volume too soft
_ Poor enunciation

ments:______

Test Summary

PARA-GRAPH	ACCURACY		COMPREHENSION		RATE	
	ERRORS	10 MINUS NO. ERRORS	NO. RIGHT (OR CREDITED)		WORDS IN ¶	TIME IN SEC.
1					26	
2					48	
3					49	
4					66	
5					105	
6					111	
7					124	
8					148	
9					186	
10					256	
	ACC. SCORE (TOT. "10 MINUS NO. ERRORS" COLUMN)		COMP. SCORE (TOT. NO. RIGHT OR CREDITED)		(1) NO. WORDS READ*	
					(2) TIME IN SEC.*	
					(1) ÷ (2)	× 60
GRADE EQUIV.					RATE SCORE (WPM)	
RATING						

*Do *not* count "ceiling" paragraph or paragraphs below "basal."

Silent Reading Test Data DATE______

TEST______

WORD MEAN. (VOCAB.) GRADE EQUIV.______

PARA. MEAN. (READ.) GRADE EQUIV.______

AVE. READ. GRADE EQUIV.______

Published 1952 by World Book Company, Yonkers-on-Hudson, New York, and Chicago, Illinois

a

PRINTED IN U.S.A. G:ORT:RB:B-3

1. I see two boys.
Here is a man.
I can see Mother.
She looks at the boys.
They look at the toys.
I see a flower.

TIME______Seconds

__1. How many boys are there?
__2. What is Mother doing?
__3. What are the boys doing?
__4. What other person do you see?
__5. What do you see that grows?

NUMBER RIGHT ______

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

2. Look at the big room.
The room has some toys.
The boys are in the room.
They play on the floor.
The man is in the big chair.
He is looking at the two boys.
Mother is sitting in a chair, too.
They all like the pretty room.

TIME______Seconds

__1. Is the room little or big?
__2. Where are the boys playing?
__3. Where is the man?
__4. What is the man doing?
__5. Where is Mother?

NUMBER RIGHT ______

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

5. On Saturday the two boys do things they enjoy. For them this is the nicest day of the week. Sometimes they help with different household duties. In warm weather Tom and Father mow the lawn. If Mother is especially busy cooking for Sunday, Ned is glad to run errands for her before lunch. The family does not always spend the day working. In summer they often visit a lake near the city, where they spend happy hours swimming and boating. In winter the boys sometimes attend a movie; or, in freezing weather, they skate with their parents. The family takes real pleasure in Saturday activities.

TIME______Seconds

__1. What is the most pleasant day of the week for the boys?
__2. What do Tom and Father do on Saturdays in warm weather?
__3. What does Ned do for Mother?
__4. Where does the family go in summer?
__5. What do the boys do with their parents in the winter?

NUMBER RIGHT ______

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

6. The month of August brings a treat for Tom and
Their uncle and aunt own a prosperous dairy farm wh
situated about one hundred miles from the city. They u
invite their nephews for a two weeks' visit. Farm l
crowded with excitement for the two boys. Shortly
sunrise they are already out in the barn, where they ob
the fascinating process of milking. After breakfast,
generally go out to the hayfield. Occasionally, they
their pretty Cousin Anne when she searches the pa
thoroughly for blueberries. To Tom and Ned countr
is so very attractive that at present they think they wi
come farmers.

TIME______Seconds

__1. In what month do Tom and Ned go to visit their and aunt?
__2. How far is their uncle's farm from the city?
__3. How long does their visit usually last?
__4. Where do they go after breakfast?
__5. With whom do they gather blueberries?

NUMBER RIGHT ______

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

3. Tom is almost ten years old.
His brother's name is Ned.
Tom is in the fourth grade.
Ned is in the second grade.
Both boys like to go to school.
They are also fond of playing ball.
When Mother and Father have time,
they aid them with their studies.

ME_____Seconds

How old is Tom?
What is his brother's name?
What grade is Tom in?
What grade is his brother in?
What do Mother and Father do when they have time?

'MBER RIGHT _____

ERROR RECORD	Number
:itutions	
ronunciations	
ls pronounced by examiner	
gard of punctuation	
tions	
ations	
titions	
sions	
Total Errors	

4. Tom and Ned live near a large city park. They often visit it with their playmates. In the park are many shady maple trees. There is a pleasant picnic ground on the hill, and the valley below has a pretty little pond. The girls always enjoy watching the boys while they sail their tiny boats in the water. Mother and Father enjoy picnics in the park.

TIME_____Seconds

__1. What kind of trees grow in the park?
__2. Where is the picnic ground?
__3. What is in the valley?
__4. What do the boys do at the pond?
__5. What do Mother and Father like to do in the park?

NUMBER RIGHT _____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

:he average boy often likes to work with his hands. At
l, besides studying regular classroom subjects, Tom and
are developing certain skills in woodwork. They are
ng to use various carpenter's tools; they are taught to
their products attractively. In order to encourage and
this interest and skill, Father has built them a little
hop in the basement. There they spend hours of their
: time tinkering. Tom has already constructed a pic-
|ue birdhouse, and later he hopes to make his mother
:kcase. Although Ned is still too young to handle many
he has nevertheless learned to use a light hammer.
r is helping him build a little footstool. Their parents
: that hobbies are valuable throughout life.

IE_____Seconds

Where has Father built the workshop for the boys?
What has Tom already built?
What is Tom planning to make for his mother?
What tool has Ned learned to use?
What is Father helping Ned to build?

MBER RIGHT _____

ERROR RECORD	Number
itutions	
:onunciations	
s pronounced by examiner	
gard of punctuation	
:ions	
ations	
:itions	
sions	
Total Errors	

8. For a great many months Father had promised Tom and Ned that they could accompany him on his next airplane trip. When the day eventually arrived, their excitement was boundless. As Mother drove them to the airport, they asked endless questions which were largely too technical for their parents to answer. While waiting at the field for their passenger plane to arrive, they watched with interest the activities of other aircraft. Their hearts quickened as they scrambled aboard the plane. A few moments later, when the heavy craft wobbled slightly, they realized that they were off the ground. Unfortunately, the huge wing obstructed the view of familiar landmarks below. They traveled in luxurious comfort; the airline's personnel were consistently courteous. The trip seemed incredibly short. Tom and Ned decided afterward that they would always travel by air. No thrill is comparable to that of your initial airplane trip.

TIME_____Seconds

__1. Who drove the boys and their father to the airport?
__2. When did they watch the activities of other aircraft?
__3. How did they know that their plane had left the ground?
__4. What kept them from seeing familiar landmarks below?
__5. What did Tom and Ned decide after their trip was over?

NUMBER RIGHT _____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

9. Tom and Ned are living in a constantly changing world. The complex society which surrounds them is never static. All its phases — whether political, economic, scientific, or artistic — are ever shifting. Science, most powerful of all influences on contemporary life, is daily producing new machines, more rapid communications, and improved modes of transportation, which are making nations of the world more closely interdependent and are constantly creating new problems for mankind. As they become adults, the boys will face a world profoundly different from the present one. They are now preparing for citizenship in it; an important part of this preparation is a basic education. Knowledge of history, for example, should enable them to judge contemporary events in light of the past, while mathematics will help them develop logical thought habits. They will need some familiarity with different languages and cultures, for as world citizens they must be alert to the problems confronting their own country and also its neighbors. Equipped, in addition, with vocational training, Tom and Ned will make valid contributions not only to their immediate communities but also to society as a whole.

TIME_____Seconds

__1. In what kind of world are Tom and Ned living?
__2. What is one of the most powerful influences on modern life?
__3. What knowledge will later help Tom and Ned judge the present?
__4. What subject will help them develop logical thought habits?
__5. What other kind of training must they have?

NUMBER RIGHT _____

ERROR RECORD	Number
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

10. Building on an interest first stimulated in high s Tom and Ned will strive throughout adulthood to se responsible participants in a world citizenry. To d and sustain an awareness of the world's multitudinous lems requires both training and unremitting effort o part of every individual; it calls for use of all our educa facilities. Formal institutions of learning naturally l the task of laying the foundations of good citizenship; ir in world affairs is normally encouraged in secondary through the department of social studies. The college cu lum provides opportunities for the extension and deepen this interest by giving students a historical perspective; a view of the humanities; a knowledge of psychology; a pecially, a sound understanding of political science. S program concerns itself both with the etiology of past worl flicts and with circumstances which have given rise to p ideologies. Once graduated from secondary school or c the individual must not relinquish his interest in world though he is necessarily preoccupied with earning a livel Informal adult educational programs offer him opportu by which he can remain cognizant of current issues. H attend excellent forums and panel discussions devoted to fication of differing viewpoints and to formulation of con tive programs aimed at promoting world peace; he may r in close touch with daily news developments through media as radio and television. But most important of educational opportunities is the selective reading pr which he should follow concomitantly with all these activities.

TIME_____Seconds

__1. What type of institution lays the foundations of citizenship?
__2. At what educational level is a student's interest in affairs usually first fostered?
__3. Name one college course that will further encoura interest in world affairs.
__4. What kind of educational programs will be availa the student after graduation?
__5. What is the most important activity in which on engage in order to keep abreast of current events?

NUMBER RIGHT _____

ERROR RECORD	Numb
Substitutions	
Mispronunciations	
Words pronounced by examiner	
Disregard of punctuation	
Insertions	
Hesitations	
Repetitions	
Omissions	
Total Errors	

APPENDIX B

SCORES OF TESTS GIVEN TO 160 CHILDREN

IN THE STUDY

KEY TO ABBREVIATIONS OF COLUMNS USED IN TABLE OF SCORES

ABBREVIATION	EXPLANATION
Pupil Code	
000.2	Grade 2
000.4	Grade 4
000.6	Grade 6
Sex	
1	Male
2	Female
C. A.	Chronological Age on day tape recording of the voice was made
I. Q.	Intelligence Quotient obtained from the California Short Form Test of Mental Maturity '53 Primary Form: Grade 2 '50 Elementary Form: Grade 4 '50 Elementary Form: Grade 6
Ed. Ach.	Educational Achievement grade equivalent from Metropolitan Achievement Test Primary II Battery, Form T: Grade 2 Elementary Battery, Form T: Grade 4 Intermediate Partial Battery, Form T: Grade 6
R. Ach.	Reading Achievement grade equivalent from Reading Tests contained in Metropolitan Achievement Test Primary II Battery, Form T: Grade 2 Elementary Battery, Form T: Grade 4 Intermediate Partial Battery, Form T: Grade 6

TABLE 55

SCORES OF TESTS GIVEN TO 160 PUPILS
IN GRADES TWO, FOUR, AND SIX

Pupil	Sex	C.A.	I.Q.	Ed. Ach.	R. Ach.
1.2	1	100*	108	3.5**	3.3**
2.2	2	99	103	3.6	3.8
3.2	2	89	122	2.3	2.9
4.2	1	93	135	3.4	3.7
5.2	1	95	120	4.5	5.1
6.2	1	107	94	3.8	3.8
7.2	2	94	115	3.8	3.5
8.2	1	88	100	2.7	2.7
9.2	1	99	111	4.9	5.6
10.2	1	94	147	4.6	5.6
11.2	2	95	103	3.5	4.1
12.2	1	96	119	4.1	4.4
13.2	1	90	136	4.9	5.6
14.2	1	94	96	4.1	4.4
15.2	2	97	122	4.6	5.6
16.2	1	93	101	3.7	4.0
17.2	1	91	126	3.0	3.1
18.2	1	95	106	2.7	2.5
19.2	2	89	113	3.2	3.6
20.2	2	96	118	4.4	4.8
21.2	2	89	137	4.3	4.9
22.2	1	91	130	3.0	3.1
23.2	1	92	122	3.0	2.8
24.2	2	91	132	3.7	4.3
25.2	1	92	125	3.5	3.5
26.2	1	93	107	3.2	3.4
27.2	2	93	106	3.2	3.3
28.2	1	105	88	3.4	3.4
29.2	1	93	114	3.4	3.8
30.2	2	90	112	2.2	2.2

(continued on next page)

*Reported in months.

**Reported in grade equivalents.

TABLE 55 (continued)

Pupil	Sex	C.A.	I.Q.	Ed. Ach.	R. Ach.
31.2	1	99	113	4.5	5.1
32.2	1	89	130	3.0	2.8
33.2	2	95	106	3.6	3.9
34.2	2	91	112	4.3	4.8
35.2	2	92	115	3.6	3.7
36.2	1	89	120	2.4	2.4
37.2	1	84	134	3.2	3.5
38.2	2	88	129	3.9	4.1
39.2	1	95	124	3.6	3.6
40.2	2	91	126	3.7	4.3
41.2	1	89	137	3.3	3.5
42.2	2	90	115	2.7	2.8
43.2	2	94	138	4.6	5.3
44.2	1	103	96	2.5	2.5
45.2	1	100	104	3.4	3.8
46.2	2	97	104	2.5	2.3
47.2	1	98	119	3.6	3.6
48.2	2	88	120	3.4	3.6
49.2	2	88	113	2.9	3.3
50.2	1	94	122	2.5	2.1
51.2	2	98	121	3.7	4.3
52.4	2	120	88	4.6	4.4
53.4	1	118	128	6.2	6.4
54.4	1	126	94	6.8	6.2
55.4	1	130	89	5.0	4.6
56.4	2	114	112	6.8	6.6
57.4	1	126	98	6.4	7.3
58.4	1	121	106	6.4	7.4
59.4	2	112	135	7.0	7.6
60.4	2	119	86	5.6	5.6
61.4	2	115	91	4.2	4.3
62.4	2	121	98	4.7	5.0
63.4	2	125	90	5.1	4.6
64.4	1	145	91	4.9	4.7
65.4	2	121	117	5.0	5.1

(continued on next page)

TABLE 55 (continued)

Pupil	Sex	C.A.	I.Q.	Ed. Ach.	R. Ach.
66.4	1	123	111	6.8	7.6
67.4	1	120	103	5.2	5.0
68.4	1	119	116	6.1	6.5
69.4	2	123	78	4.2	3.5
70.4	1	128	92	4.7	4.3
71.4	1	123	95	4.9	5.0
72.4	1	114	90	4.9	5.0
73.4	2	115	134	7.8	9.2
74.4	2	122	81	4.4	4.0
75.4	1	118	96	5.4	6.3
76.4	1	117	103	4.8	4.8
77.4	2	114	112	6.3	5.6
78.4	2	114	90	5.1	4.8
79.4	2	118	134	6.2	6.3
80.4	1	116	132	6.0	7.5
81.4	1	120	88	5.8	5.2
82.4	1	126	83	5.4	5.4
83.4	1	125	93	4.9	4.3
84.4	1	120	110	6.1	6.6
85.4	1	127	91	5.0	4.8
86.4	1	120	94	4.8	4.7
87.4	1	113	123	7.5	9.2
88.4	2	108	143	7.2	8.6
89.4	1	128	81	4.8	4.6
90.4	2	122	85	4.6	4.1
91.4	2	119	86	5.7	5.0
92.4	1	125	100	5.1	4.8
93.4	1	121	102	4.7	4.3
94.4	2	112	113	6.1	6.8
95.4	1	124	100	6.0	5.1
96.4	1	118	83	5.5	4.4
97.4	1	112	123	5.8	6.1
98.4	1	118	101	4.6	4.2
99.4	1	116	114	6.3	6.3
100.4	2	113	116	6.4	7.4

(continued on next page)

TABLE 55 (continued)

Pupil	Sex	C.A.	I.Q.	Ed. Ach.	R. Ach.
101.4	2	119	130	7.6	8.6
102.4	2	118	91	6.3	5.9
103.4	1	116	97	4.9	5.0
104.6	1	143	129	9.9	11.2
105.6	1	142	98	6.6	6.6
106.6	1	140	123	9.0	99.4
107.6	1	146	124	9.7	10.2
108.6	1	139	129	9.6	9.0
109.6	2	142	97	8.5	9.3
110.6	2	138	129	9.7	10.8
111.6	1	147	122	10.9	11.5
112.6	1	139	131	10.6	11.5
113.6	1	150	116	10.0	10.8
114.6	1	139	114	7.9	9.0
115.6	1	136	107	9.3	10.0
116.6	2	140	117	8.7	8.9
117.6	1	139	129	9.8	11.5
118.6	1	142	123	8.9	10.5
119.6	2	141	117	9.9	11.5
120.6	1	143	131	9.6	10.1
121.6	2	138	112	7.0	6.8
122.6	2	132	112	7.9	7.2
123.6	1	137	111	7.8	8.9
124.6	2	145	117	8.9	8.5
125.6	1	147	80	6.6	7.6
126.6	1	136	126	9.3	10.7
127.6	2	135	95	6.9	6.9
128.6	1	142	110	8.1	9.2
129.6	2	138	127	10.0	11.5
130.6	2	144	115	7.9	6.8
131.6	1	140	111	9.7	10.1
132.6	2	138	119	8.8	7.9
133.6	1	136	118	9.1	10.0
134.6	1	143	116	8.5	9.6
135.6	2	149	80	5.9	8.0

(concluded on next page)

TABLE 55 (concluded)

Pupil	Sex	C.A.	I.Q.	Ed. Ach.	R. Ach.
136.6	1	142	91	6.1	6.3
137.6	1	138	114	9.0	10.2
138.6	1	142	103	6.7	6.2
139.6	1	141	108	8.3	11.2
140.6	1	138	109	7.4	7.7
141.6	2	141	112	8.0	8.0
142.6	2	145	121	9.0	10.0
143.6	1	143	99	6.9	7.3
144.6	2	149	114	7.0	6.9
145.6	2	135	129	9.9	10.8
146.6	1	153	126	9.5	10.9
147.6	1	147	106	7.1	7.5
148.6	2	143	117	8.6	9.4
149.6	2	146	101	6.9	7.5
150.6	2	137	102	6.5	6.6
151.6	1	151	75	5.8	5.5
152.6	1	158	93	6.5	6.1
153.6	2	141	125	9.9	11.1
154.6	2	147	85	5.9	6.0
155.6	1	141	103	6.4	6.6
156.6	1	152	96	7.6	9.1
157.6	2	137	101	7.2	6.9
158.6	1	136	108	7.8	9.4
159.6	1	136	97	6.8	7.1
160.6	2	139	117	8.1	8.6

APPENDIX C

MEAN PITCH OF VOICE OF 160 CHILDREN

IN THE STUDY

KEY TO ABBREVIATIONS OF COLUMNS
USED IN TABLE OF MEAN PITCH OF VOICE

ABBREVIATION	EXPLANATION
Pupil Code	
000.2	Grade 2
000.4	Grade 4
000.6	Grade 6
C.S.	Conversational Speaking
E.R.	Reading of material one year below instructional level, so-called Easy Reading
R (I)	Unaided Oral Recall of Easy Reading
D.R.	Reading of material one year or more beyond instructional level, so-called Difficult Reading
R (II)	Unaided Oral Recall of Difficult Reading

TABLE 56

MEAN PITCH OF THE VOICE OF 160 PUPILS

Pupil	C.S.	E.R.	R (I)	D.R.	R (II)
1.2	258.7	260.0	259.0	258.8	257.5
2.2	250.0	265.0	263.6	266.6	256.4
3.2	257.9	258.3	254.0	257.8	254.0
4.2	260.4	266.6	268.3	260.9	260.0
5.2	256.4	261.4	260.0	267.1	262.5
6.2	250.0	253.0	250.0	249.2	248.3
7.2	255.3	256.9	255.3	253.7	251.0
8.2	250.0	252.0	248.0	254.0	251.0
9.2	242.0	256.9	251.0	257.6	252.0
10.2	250.0	250.0	250.0	253.0	248.0
11.2	250.0	260.0	254.0	260.0	254.0
12.2	255.0	270.8	266.0	265.4	259.3
13.2	251.8	251.7	254.0	252.0	247.5
14.2	259.2	256.0	253.3	255.5	252.6
15.2	252.0	255.0	261.4	259.3	259.0
16.2	253.3	249.2	251.8	254.2	248.1
17.2	261.7	253.1	242.3	256.2	248.5
18.2	256.4	259.0	255.0	260.0	251.0
19.2	254.0	245.0	249.1	251.8	251.0
20.2	253.2	266.6	250.0	264.5	251.0
21.2	249.0	254.5	251.0	249.2	247.7
22.2	264.1	252.8	253.3	259.4	258.4
23.2	268.0	264.5	260.0	258.5	257.5
24.2	249.4	253.1	259.0	257.8	256.0
25.2	256.7	270.9	251.3	262.4	259.1
26.2	256.2	272.5	265.4	269.3	270.0
27.2	254.4	256.0	251.7	258.3	254.2
28.2	256.0	262.0	260.0	264.3	260.0
29.2	250.0	269.0	259.0	260.0	254.5
30.2	263.8	255.4	251.0	259.0	260.0
31.2	243.0	250.7	246.4	246.7	239.1
32.2	260.0	256.5	249.2	253.5	253.8
33.2	252.1	252.8	251.8	257.8	249.7
34.2	248.5	257.7	247.3	250.8	250.0
35.2	252.5	263.1	255.3	261.5	261.9

(continued on next page)

TABLE 56 (continued)

Pupil	C.S.	E.R.	R (I)	D.R.	R (II)
36.2	264.3	265.0	256.1	265.7	259.0
37.2	258.9	273.3	260.0	265.7	254.5
38.2	260.0	265.8	264.5	259.4	260.0
39.2	249.0	246.3	247.0	241.7	244.0
40.2	256.0	264.1	260.0	262.6	255.0
41.2	247.8	260.0	258.6	255.4	265.0
42.2	246.7	245.5	250.0	248.4	250.0
43.2	261.3	259.0	259.0	262.5	260.9
44.2	246.7	252.5	250.0	248.3	246.0
45.2	246.4	248.6	246.0	245.0	247.5
46.2	254.3	255.4	260.7	262.0	257.7
47.2	252.1	254.0	250.0	256.7	256.0
48.2	259.4	257.9	254.8	260.6	261.0
49.2	258.3	260.0	254.6	261.3	257.0
50.2	259.4	266.4	255.0	256.3	257.0
51.2	257.6	262.0	258.0	258.4	259.3
52.4	254.3	263.1	253.1	258.5	257.5
53.4	257.7	270.9	262.1	264.2	257.3
54.4	248.6	249.1	250.0	249.3	245.0
55.4	260.9	280.8	267.3	274.3	262.7
56.4	244.8	246.0	236.7	240.0	239.4
57.4	255.8	270.9	266.0	268.6	261.8
58.4	246.7	254.5	245.3	260.6	251.0
59.4	251.6	270.0	251.0	267.0	252.8
60.4	240.1	233.0	234.0	235.3	240.0
61.4	258.2	268.5	259.0	269.2	262.0
62.4	250.0	267.8	257.3	265.2	252.3
63.4	248.1	252.8	242.5	250.0	244.6
64.4	250.0	254.0	251.0	255.7	250.8
65.4	253.8	266.7	264.2	264.0	266.0
66.4	250.6	265.4	252.7	270.0	254.6
67.4	252.4	273.1	273.3	266.0	265.4
68.4	256.7	271.8	256.2	269.3	266.4
69.4	256.8	263.0	255.5	260.8	260.0
70.4	269.4	274.0	263.0	263.0	272.0

(continued on next page)

TABLE 56 (continued)

Pupil	C.S.	E.R.	R (I)	D.R.	R (II)
71.4	255.5	261.0	261.0	260.0	260.0
72.4	262.1	265.6	261.8	265.0	256.4
73.4	245.6	253.1	250.0	253.1	246.7
74.4	253.2	270.6	255.0	268.5	257.0
75.4	250.7	259.3	255.0	255.4	255.3
76.4	257.0	263.9	263.0	263.3	256.7
77.4	249.4	253.0	250.8	243.8	248.0
78.4	250.0	256.0	249.2	249.0	248.0
79.4	253.5	259.1	253.0	260.0	254.5
80.4	256.0	261.9	256.7	268.4	260.9
81.4	231.3	229.0	237.3	236.7	237.0
82.4	250.0	258.0	249.0	255.0	251.8
83.4	243.2	247.3	247.3	248.3	240.0
84.4	262.7	262.3	263.3	260.5	262.0
85.4	246.5	247.0	241.7	247.3	242.0
86.4	250.7	258.5	246.7	265.7	245.5
87.4	254.1	278.5	266.7	262.2	259.2
88.4	257.1	278.8	260.0	265.7	262.0
89.4	250.9	258.7	255.8	255.7	257.3
90.4	258.5	266.0	258.2	282.7	271.7
91.4	248.0	257.0	252.0	255.7	255.4
92.4	236.0	240.1	241.0	238.7	239.2
93.4	266.8	275.8	267.0	266.4	265.0
94.4	253.8	260.9	256.2	263.8	261.3
95.4	251.8	260.0	258.7	250.0	256.2
96.4	259.1	265.0	265.5	256.9	256.7
97.4	252.3	266.4	255.4	262.0	253.0
98.4	260.0	260.0	261.8	266.4	259.2
99.4	245.7	253.1	252.0	251.0	247.3
100.4	260.7	263.1	256.9	260.0	261.8
101.4	245.0	242.7	241.0	244.0	243.8
102.4	246.5	257.6	245.5	261.3	255.8
103.4	263.3	265.0	262.1	263.0	264.5
104.6	250.0	264.5	250.9	257.1	249.0
105.6	250.0	248.2	250.0	249.2	249.0

(continued on next page)

TABLE 56 (continued)

Pupil	C.S.	E.R.	R (I)	D.R.	R (II)
106.6	250.0	266.6	261.3	264.7	251.0
107.6	249.2	258.1	254.5	260.0	253.0
108.6	250.7	260.8	256.9	259.2	249.0
109.6	252.7	259.2	251.4	261.0	253.0
110.6	256.0	260.7	264.5	260.8	255.0
111.6	250.5	251.8	250.0	250.0	249.2
112.6	251.7	259.3	253.1	254.0	254.2
113.6	254.7	266.0	256.0	262.7	257.0
114.6	250.0	270.0	253.6	269.1	256.9
115.6	252.2	252.7	250.0	254.0	250.0
116.6	250.0	251.5	252.7	253.9	252.1
117.6	253.6	261.4	254.0	260.0	253.0
118.6	246.0	260.8	254.0	262.8	253.0
119.6	251.7	252.5	250.0	250.6	250.0
120.6	250.9	259.4	254.5	253.6	248.2
121.6	251.8	261.7	249.0	254.1	249.0
122.6	251.8	250.0	247.0	248.3	250.0
123.6	252.3	252.8	250.0	256.1	251.9
124.6	251.0	257.5	250.0	259.2	255.0
125.6	250.0	260.9	254.0	260.0	251.0
126.6	260.4	272.8	264.0	268.0	263.6
127.6	256.0	269.4	265.5	264.3	260.0
128.6	259.2	265.6	258.0	269.0	263.3
129.6	248.0	250.8	250.0	250.7	248.2
130.6	253.0	260.7	256.7	245.3	257.5
131.6	254.3	258.3	257.5	257.0	255.5
132.6	251.0	275.3	253.0	267.7	256.7
133.6	256.0	267.1	260.0	267.3	258.0
134.6	252.7	270.0	269.2	265.0	269.1
135.6	250.0	245.0	240.0	250.0	242.0
136.6	250.8	253.6	251.5	253.0	249.2
137.6	257.9	267.0	268.2	276.0	266.0
138.6	250.8	254.6	252.7	257.0	252.1
139.6	255.3	259.4	258.0	258.0	256.7
140.6	250.0	256.9	253.0	260.8	257.0

(concluded on next page)

TABLE 56 (concluded)

Pupil	C.S.	E.R.	R (I)	D.R.	R (II)
141.6	250.0	262.9	260.0	258.0	257.3
142.6	257.5	267.3	265.0	272.0	263.0
143.6	260.0	260.9	260.0	259.1	260.0
144.6	251.7	264.0	256.0	262.7	252.0
145.6	251.3	263.0	254.6	260.0	252.3
146.6	253.0	260.9	253.0	261.8	254.7
147.6	256.8	260.9	259.2	262.5	258.2
148.6	251.8	251.8	254.0	252.2	250.0
149.6	252.6	261.1	261.0	266.7	256.7
150.6	258.5	266.0	258.2	282.0	271.7
151.6	250.0	260.7	250.8	262.4	240.0
152.6	244.0	239.0	246.0	244.2	242.0
153.6	252.5	263.2	251.0	259.2	254.0
154.6	238.6	253.6	250.0	252.5	250.0
155.6	250.4	262.7	254.0	256.4	252.5
156.6	251.3	267.5	261.8	262.7	262.0
157.6	240.0	259.4	250.0	256.2	251.0
158.6	250.0	251.6	252.4	250.0	252.0
159.6	260.7	263.5	263.6	265.8	265.0
160.6	250.8	258.7	253.3	261.3	251.0

APPENDIX D

RELIABILITY STUDIES

OF PURDUE PITCH METER RECORDINGS

TABLE 57

RELIABILITY OF SCORING PITCH OF VOICE RECORDINGS

Pupil N 10	Pitch Meter Recording of Fundamental Frequency	
	First Scoring Mean (cps)	Second Scoring Mean (cps)
1	261.8	260.8
2	261.7	261.4
3	261.2	261.7
4	259.4	257.1
5	257.7	258.3
6	257.2	259.2
7	255.9	255.0
8	255.2	254.8
9	253.2	253.2
10	252.4	250.3

rho = .90

$\sigma_r = \pm .063$

TABLE 58

RELIABILITY OF ABRIDGED TECHNIQUE
OF SCORING PITCH OF VOICE RECORDINGS

Pupil N 30	Pitch Meter Recording of Fundamental Frequency	
	Full Scoring Mean (cps)	Abridged Scoring Mean (cps)
1	266.8	268.0
2	266.6	264.3
3	265.3	262.5
4	263.4	260.0
5	259.2	260.0
6	258.4	256.7
7	257.9	258.9
8	257.8	257.6
9	257.1	256.3
10	256.8	256.0
11	256.8	256.0
12	256.7	256.2
13	256.2	255.0
14	252.6	252.7
15	252.4	243.6
16	252.2	252.0
17	251.8	251.2
18	251.6	251.7
19	250.8	251.8
20	250.6	252.2
21	250.4	249.2
22	250.0	250.0
23	249.2	248.9
24	249.2	249.0
25	248.6	248.8
26	248.1	247.5
27	247.0	247.8
28	244.8	245.0
29	243.2	245.0
30	242.0	240.0

rho = .99

$\sigma_r = \pm .003$

TABLE 59

RELIABILITY OF PITCH OF VOICE SAMPLE

Pupil N 38	Pitch Meter Recording of Fundamental Frequency	
	Paragraph A Mean (cps)	Paragraph B Mean (cps)
1	277.5	270.9
2	271.2	264.5
3	270.0	272.5
4	268.4	265.0
5	267.4	273.3
6	267.0	257.9
7	265.3	270.8
8	264.7	263.0
9	263.7	252.2
10	263.5	263.1
11	260.6	256.5
12	260.5	256.0
13	260.0	262.0
14	259.3	252.8
15	258.3	255.4
16	256.0	253.1
17	255.9	266.6
18	253.5	260.0
19	251.8	245.5
20	274.8	262.4
21	270.0	253.5
22	269.1	266.4
23	267.8	265.7
24	267.0	255.4
25	266.6	269.3
26	265.5	260.6
27	265.5	256.2
28	264.1	258.4
29	261.5	265.4
30	261.3	258.5
31	260.9	260.3
32	259.8	255.5
33	259.2	260.9
34	258.9	259.0
35	258.0	260.8
36	257.9	259.4
37	256.7	257.8
38	251.7	248.4

rho = .84

$\sigma_r = \pm .048$

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