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A PRELIMINARY STUDY OF PITCH INFLECTION IN
THE SPEECH OF PRESCHOOL CHILDREN

MELVIN S. HATTWICK

Individual and group studies of the language development of children have largely centered about the meaningful content including vocabulary, the production of speech sounds, and growth in the use of the sentence. Practically no studies have been made of the expressive side of language development including pitch variation, vocal quality, accent and emphasis, and the temporal organization of the language units.

The present study is a preliminary investigation of another expressive variable in the language development of the young child, namely, pitch inflection. The results of such study may have important relationships to numerous problems. Williams has recently pointed out that pitch inflection may be of considerable significance in the comprehension of language. Certain relationships between pitch abnormality in speech and stuttering have been shown by Travis. The development of natural pitch inflection forms one of the most difficult items in the training of the deaf. There is need for a simple and reliable means for estimating progress in such cases. Studies in the development of vocal pitch in children also have an important bearing on the general problem of speech melody in theoretical phonetics.

The most immediate purpose of this study is the derivation of an additional technique which might be used for studies of musical development of children, particularly in relation to the development of pitch consciousness. It is possible to study a considerable variety of pitch characteristics in speech, such as the general pitch level; the average range; the ratio of phonated time to silent time; and the occurrence of various inflectional forms, such as rising and falling inflections, the circumflex, the sustained tone, and the vibrato. As standards of artistic intonation are developed, it may become possible to study many other features in a more definite way.

Undoubtedly the most adequate technique for studies of this kind would be to take objective records such as might be obtained with the phonelescope or strobophotographic camera. Such a method requires, however, expensive apparatus and a degree of

technical skill which would make it undesirable for general or routine measurement of children. There is also a question as to whether results obtained from young children by such a method would be valid. It was decided, therefore, in this study to investigate the possibilities of the observational method. The data included in this report are confined to the observational measurement of two variables in the pitch inflections of children's speech, the determination of the general pitch level, and the range of variation in individual children.

PROCEDURE

To gain an orientation in the problem two preliminary procedures were used. In the first the observers were instructed to note the highest and lowest pitch in a sentence unit and to record the range in relative terms, for example, a minor third or a major sixth. In the second procedure they were provided with a pitch pipe and merely required to record in absolute terms the highest and lowest pitch in a sentence unit. Each observer was instructed to memorize the two pitch levels heard and to check the absolute location on the musical scale. Checking the tones with the pitch pipe made the second method much easier, on the whole, for the observers than the first. It had the further advantage of giving the absolute level of the tones observed. From these records the relative pitch range might be easily obtained.

The success achieved by the method suggested the next step, the memorization and recording of the pitch levels in an entire unit of expression. These were placed on a specially prepared blank scaled in half tone units. By this method, therefore, the dominant pitch of each syllable was recorded by writing the actual content on the proper line in the blank. In addition, rising and falling inflections for each syllable or between syllables were indicated by pencil lines when clearly perceptible. By this procedure the syllable was made the unit of recording; while the sentence, or some analogous meaningful whole as expressed by the child, was made the unit of observation. The sentences were usually very short. Where they exceeded the ordinary adult attention span of six or seven words, the first part of the sentence was recorded, i.e., as many syllables as could be clearly remembered.

The adequacy of such a method deserves particular comment in view of the well-known intricacy of pitch variation in speech. Several arguments may be advanced in its favor. In the first place Root has definitely shown that (1) many of the more com-

plex and rapid physical variations in speech pitch are not perceived as they actually are, and (2) there is a definite tendency in perception to interpret many of these variations as a unipitch at some definite point. The present technique definitely makes use of the second of these principles, supplementing it by recording inflectional change where this was clearly perceptible.

No attempt was made to obtain a consecutive record of each child's speech. Instead the observers recorded the speech melody only for those sentence units in which they had understood the words and could image quite vividly the inflectional characteristics.

RELIABILITY OF OBSERVATION

The two principal observers in this study, X and Y,¹ were given several hours of practice on consecutive days in one of the preschool laboratories of the Iowa Child Welfare Research Station. The observers recorded random conversation in the group, each listening to the same sentence of a given child or of several children and writing down as much as possible. During the practice period observers X and Y compared notes frequently. The degree of progress made by these two observers in recording is shown by the following correlations between independent records: At the beginning of a two week period the correlation was $.77 \pm .016$ (94 syllable units); at the end of the period two correlations taken on successive days gave, respectively, $.87 \pm .007$ (145 syllable units) and $.85 \pm .008$ (133 syllable units).

As a further check on the adequacy of this type of report, the judgments of each of the observers were compared with an objective record of pitch variations.

In the experience of the writer the following principles of observation seem to be important in obtaining reliable judgments: (1) only those sentences should be recorded in which the content and pitch variations are clearly imaged. (2) The sampling should be limited to six or seven words at one time. For the best results the general orientation in the scale should be checked frequently with the pitch pipe and, as nearly as possible, just before making an observation memorization of the sentence as a unit is essential for correct placement of the individual syllables. Immediate vocal imitation of the speech melody is also of great assistance in fixing the curve in mind.

¹ These observers were Melvin S. Hattwick, and Dr. Harold M. Williams. Both have high ratings in the Seashore Measures of Musical Talent, as well as considerable general training in music. Neither observer can be classified as possessing a high degree of absolute pitch, but each could remember a series of absolute pitches quite accurately for several minutes.

CONDITIONS OF SAMPLING OF THE CHILD'S SPEECH

The next question to arise is that of the conditions under which a fair sampling of the child's pitch characteristics can be secured. From preliminary observation it seemed evident that in certain situations, such as excited group play, shouting across the room, or in talking to self, the general pitch level of the child's voice might deviate from that used in quiet conversational speech with another child or an adult.

Observations were taken, therefore, for a group of ten children having an age range from three years and nine months to four years and ten months, sentence units being classified under the following heads: (1) talking to self, (2) talking to another child or adult, (3) conversation in a group at play, and (4) shouting at a distance of more than ten feet from the person addressed.

For each situation a sampling of at least sixty syllable units was obtained from all but one child. As might be expected the distribution in a consecutive sampling was not equal for the four categories. Some children talked in groups to a much greater extent than to themselves; others were quiet in group activities yet quite active vocally when playing alone. The policy followed by the observer was to record the sentence units of the children as he heard them, noting their classification as 1, 2, 3, or 4. Situations 2 and 3 were the most common in a running sample. Longer periods of observation were, therefore, necessary to obtain the sampling for situations 1 and 4.

The group means indicate that in each of the four situations the children tend toward somewhat different mean pitch levels. When talking alone the mean is slightly below F#, when talking to another child or to an adult it is almost G#. Group conversation is slightly higher having a mean pitch level somewhat above A, while the level for shouting is close to B. The greatest difference of pitch levels used in the various situations is that between the first and fourth where the means are separated by five half tones. The smallest difference is between situations two and three where the means are separated by slightly more than one-half tone. The

Table I.

SITUATIONS	MEAN DIFFERENCE	STANDARD DEVIATION OF DIFFERENCE
1 and 2	8.5	1.0
1 and 3	12.2	.4
1 and 4	14.3	1.5
2 and 3	4.6	.9
2 and 4	8.5	2.5
3 and 4	4.5	.4

statistical significance of the differences according to Rietz's² Formula 13 for a small number of cases is shown in table I.

Statistically the differences in mean pitch level are all significant. An interesting contrast to this result is found in the variability scores where none of the differences are particularly significant. The small number of cases undoubtedly invalidates these results to some extent; in a larger sampling these differences might disappear.

In view of the fact that these differences are all so small in relation to the original accuracy of recording, it is probable that with the exception of the two extreme cases of mean pitch level the differences are meaningless. For the measurement of individual differences, therefore, a running sampling of a child's conversational speech would seem to be a fair measure.

RELIABILITY OF SAMPLING

To determine the reliability of sampling for each child, eleven additional children were observed under the conditions recommended above, thus making a total of twenty children available for the correlation. A minimum of sixty syllables was recorded for each of these children. Averages and standard deviations were calculated for chance halves of these samplings for each additional subject and for a comparable number of sentence units from the first group of children. The correlations thus obtained were for the mean pitch level $.89 \pm .016$ (20 children), for the variability $.62 \pm .094$ (20 children). For the sampling as a whole these correlations become $.94$ for the mean pitch level and $.76$ for the variability of pitch using the Spearman-Brown formula. These figures show that a reliable sampling of the mean pitch level of a child's speaking voice may be obtained under the conditions described above with a sampling of about sixty syllables. A considerably longer sampling than this is necessary to obtain a stable index of his pitch variability. It must be remembered that these figures were obtained for each child by short sampling over several days and therefore, should be fairly representative. They refer, however, only to normal conversational speech.

INDIVIDUAL DIFFERENCES

A statement of individual mean and variability scores for the twenty children is given in Table 2. The differences in mean pitch level are, on the whole, surprisingly small. The standard deviations

² Rietz, Henry Lewis: *Mathematical Statistics*. Carus Mathematical Monog., No. 3. Chicago: Open Court Publishing Co., c. 1927. Pp. xi, 181. (P. 128).

vary more, some children being nearly twice as variable as others.

The small individual differences revealed by this technique contrast strikingly with the apparently great differences in the pitch of the children's voices as revealed by casual observation. In the opinion of the writer these apparent differences are largely qualitative in character, the heavy voice presenting an illusion of low pitch and the light, pure voice producing an illusion of high pitch.

SUMMARY AND CONCLUSIONS

In this study an experimental evaluation has been made of the possibilities of the observational method for measuring two aspects of pitch variable in the expressive use of language by pre-school children. The two variables measured were (1) the determination of the general pitch level, and (2) the range of the variability or flexibility in individual children.

With the aid of a pitch pipe the perceived pitch locations of consecutive syllables in a sentence unit were graphed in absolute terms. The following conclusions were reached:

1. A reliability, sufficiently satisfactory to roughly classify children was obtained for two observers in terms of correlations between their own records and an objective record. The evidence indicated, however, that a rather high degree of care in the selection and training of observers is necessary.

2. With regard to the conditions of sampling of the child's spontaneous language activity, it was found that the mean pitch level of children was lowest when talking to themselves; and that talking to another child or adult, talking in groups, and shouting followed in ascending order. There appeared to be significant differences in mean pitch level between these situations, particularly between the two extremes of talking to self and shouting. Changing the situation did not affect the variability of pitch significantly.

3. A running sample of conversational speech with another child, an adult, or small group is recommended for individual measurement, particularly because these are the situations in which pitch is most important as a factor in the expressive use of language.

4. The reliability of a sampling of sixty syllables per child was satisfactory for determining the general pitch level of speech, but the sampling should be considerably longer for ascertaining reliably the variability of pitch.

5. Individual differences in variability of pitch were more outstanding than differences in mean pitch level. It was suggested that an illusion of pitch difference may be introduced in ordinary perception by qualitative differences in voices.

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