OPTIMAL AND HABITUAL PITCH IN CHILDREN'S VOICE PRODUCTIONS

by

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ABSTRACT

Twenty-four subjects, equal numbers of boys and girls, with an age range from eight to twelve, were tape recorded while reading aloud, sustaining the /a/ vowel, humming, saying hello, producing /əhʌm/ and engaging in spontaneous speech. All subjects were free of voice disorders. The results showed that the mean fundamental frequency of spontaneous speech was significantly lower than that produced in other vocal conditions tested. Additionally, all measurements of optimal pitch (i.e., humming, saying /əhʌm/ and "hello") were significantly higher than measurements of habitual pitch (i.e., reading, producing /a/ and spontaneous speech).

Voice therapy techniques frequently presume that the client is producing an habitual pitch that is "inappropriate" (i.e., too low or too high) for the subject's vocal mechanism. The assumption is that this "inappropriate" habitual pitch may cause damage to the vocal mechanism, thereby resulting in production of a deviant voice.

There is some discrepancy in the literature as to whether the "inappropriate" habitual pitch is too high or too low in clients with voice deviations. Several authors suggest that vocal nodules are caused by too high a pitch (West and Ansberry, 1968; Van Riper and Irwin, 1958; Anderson, 1961; Wilson, 1966). Others believe the habitual pitch is too low in many clients with nodules (Luchsinger and Arnold, 1965; Fisher and Logemann, 1970). Such discrepancies call attention to the accuracy of clinicians in assessing the "appropriateness" of their client's habitual pitch.

For voice clinicians to conclude that a client's habitual pitch is "inappropriate" they should be able, clinically, to determine the "appropriate" pitch for a given vocal mechanism. For purposes of this paper, "appropriate" or "optimal" pitch is that vocal pitch level that can be produced with the greatest economy of physical effort and energy. Optimal pitch is distinguished from habitual pitch in that the latter is the average fundamental frequency computed from the frequencies used in a client's everyday voice. Several authors have suggested that a normal individual, free of vocal disorders, has an habitual pitch and optimal pitch that are the same (Fairbanks, 1960; Boone, 1971; Wilson, 1972). If the voice clinician discovers a discrepancy between optimal and habitual pitch in a client, the aforementioned authors recommend a change be instituted in the habitual pitch.

Such therapy strategies are reliant upon the accuracy of clinical techniques of assessing both optimal and habitual pitch levels. Boone (1971) and Cooper (1973) suggest assessing habitual pitch by taking samples of spontaneous speech and extracting a modal or mean pitch from these samples. Several authors have

suggested that habitual pitch could be measured from samples of reading and reciting nursery rhymes (Fairbanks, 1960; Boone, 1971; Cooper, 1971; Wilson, 1972). Additionally, Boone (1971) suggests that habitual pitch can be estimated by prolongation of vowels and extraction of pitch through PAD Pitch-meter, or in connected speech by use of the Fundamental Frequency Indicator developed by Hollien et al. 1968. Habitual pitch is assumed to be accurately assessed through use of any of these various methods.

Several authors have suggested that methods that promote relaxation of the vocal mechanism are most likely to result in productions of optimal pitch (Boone, 1971; Cooper, 1971; Perkins, 1971). Such methods include easy vocalizations such as sighs, laughs, producing /əhʌm/ or saying "hello". Thurman (1958) proposed a method where the client hums or sings a scale; the pitch where the listener experiences a "swell" in volume and quality represents the optimal pitch. House (1959) took issue with this method on the basis of vocal tract resonance.

There are several methods described in the literature to assess both optimal and habitual pitches; however, most of these procedures are based on information obtained from adult speakers. There are few, if any, reports in the literature which objectively describe the level of agreement between optimal and habitual pitch for any age group. If such methods are accurate in assessing optimal and habitual pitch in children, we would not expect these two measures to differ significantly within children free of vocal disorders. We would assume that children free of vocal pathologies would be habitually speaking at their optimal pitch level. The question of interest is, *Do measures of optimal and habitual pitch obtained through various clinical procedures differ significantly within children free of vocal pathologies?* Habitual pitch measures were obtained from samples of spontaneous speech, reading and vowel prolongation, while optimal pitch measures were obtained from a sample of humming, saying /əhʌm/ and "hello".

Method

Subjects

The sample consisted of 24 subjects, selected by the School Speech-Language Pathologist, from grades 2 through 6. The Speech-Language Pathologist was asked to select those free of communicative problems. The subjects were divided equally by sex, and ranged in age from 8-2 to 12-3. The mean age for boys was 127 months (10-7) and the mean age for girls was 128.08 months (10-8). All subjects were rechecked before recording to determine normal voice function. School health records indicated no history of voice disorders. Indirect laryngeal exams were not attempted.

Materials

A Uher 4200 portable tape recorder was used to record the speech samples in a quiet, isolated section of a library study area, i.e. carpeted, with sound absorbent wall covering. A picture was used to elicit a spontaneous speech sample. The picture depicted a woman in a nurse's uniform, talking to a young child.

Procedures

Each subject was asked to read a standard paragraph, *Lazy Jack,* silently, and invited to ask for assistance on any difficult word. They were then instructed to read the passage three times, consecutively. The subjects then produced the vowel /a/ for as long as they were able and hummed several bars of "Jingle Bells;"

each activity was produced three times, and activities were first modelled by the experimenter. Each subject imitated three productions of "hello" and /əhʌm/. Finally, the subject was asked to describe a picture. All verbal productions were recorded at 19 cm/s.

Fundamental frequency was extracted through Visicorder analysis for the approximate middle two seconds of spontaneous speech and the third production of each of the other five conditions, (i.e. reading one sentence[1], the middle two seconds of the vowel "ah" – prolonged for at least 6 seconds, the second two seconds of humming, saying "hello" and producing /əhʌm/). A Honeywell 1508 Visicorder Oscillograph, with a paper speed of 100 cm / second, provided the printout which was used to analyze the mean fundamental frequency. The quasi-periodic waves in each 10 cm segment were multiplied by a factor of 10. No segment was used when less than 10 cm presented identifiable reoccurring wave forms. The number of 10 cm segments used for analysis of each activity was divided by 10. The mean fundamental frequency for each subject for each condition was treated to a repeated measures Analysis of Variance with fundamental frequency as the dependent measure.

Result

The main effect of sex was not significant; $F(1,22)$-1.80. The main effect of Condition Type was significant; $F(5,110)=29.48$, $p<.01$. Bonferroni t-tests were used as follow-up procedures to test the difference between means (Miller, 1966). The mean F_0 measures for each condition of habitual and optimal pitch were found to be significantly higher than the mean F_0 for spontaneous speech within subjects. These results are represented graphically in Figure 1. Reading was the condition closest in the mean F_0 to spontaneous speech, (t.99 (110)=2.8), followed in order by vowel prolongation, saying "hello," producing /əhʌm/ and humming, respectively; $t.99(110)=3.49$; $t.99(110)=5.46$; $t.99(110)=9.46$ and $t.99(110)=9.66$. It is of interest to note that the two traditional measures of habitual pitch (reading and vowel prolongation) were, in fact, the closest in mean F_0 to that measured in spontaneous speech. All measures designed to elicit optimal pitch were much higher in the mean F_0 than the mean F_0 found in spontaneous speech. These results suggest that either optimal pitch is higher than habitual pitch in this sample of 24 normal children or that the selected techniques of assessing optimal pitch may not accurately measure that parameter of pitch in children.

Discussion

The results indicate that the mean F_0 in spontaneous speech does not directly correspond to the mean F_0 obtained from techniques sometimes used to assess optimal and habitual pitch clinically, (i.e. reading, vowel prolongation, humming, saying "hello" and /əhʌm/). These measures, in fact, produced a higher mean F_0 than found in spontaneous speech for this sample of 24 children. Additionally, all three measures of optimal pitch (i.e. humming, saying "hello" and /əhʌm/) were significantly higher in the mean F_0 than the three measures of habi-

Footnote

[1] There once was a boy named Jack.
He lived in a red house with a white roof.
(His *mother worked hard each day feeding the pigs and chickens or washing clothes in a big tub.*) But all Jack did was to play with the squirrels or sit in a chair by the stove and sleep.

tual pitch, (i.e. spontaneous speech, reading and vowel prolongation). If the measures employed in this study to obtain optimal pitch measurements actually do measure optimal pitch, we must question the assumption that children speaking at habitual pitches lower than their optimal pitches produce vocal fold pathologies, e.g. vocal nodules. Habitual pitch was lower than the "optimal" level in 23 out of this sample of 24 children and all were free from acoustically perceivable vocal pathologies. Another possibility is that these measures of optimal pitch (i.e. humming, saying "hello" and /əhʌm/) did not measure optimal pitch in these 24 children.

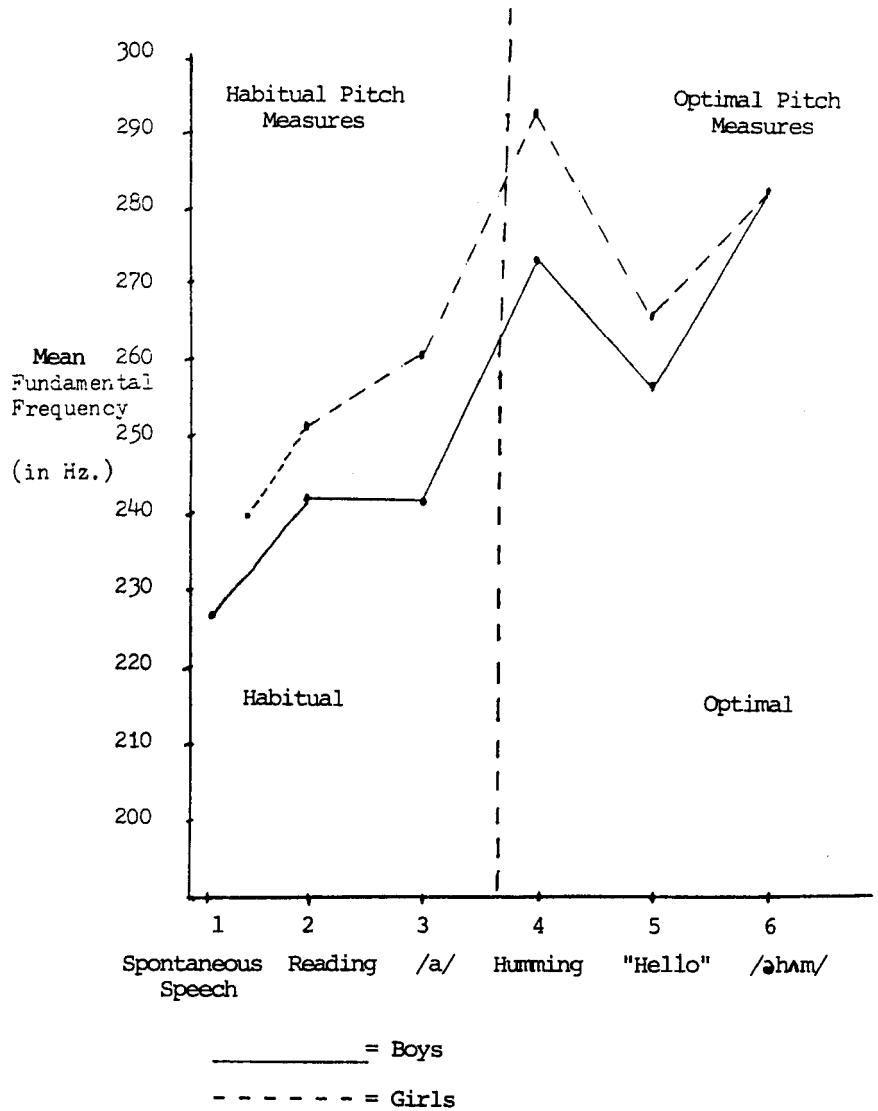

Figure 1. Mean fundamental frequency for six different speech conditions for boys and girls.

In summary, measures of optimal and habitual pitch obtained through various clinical procedures differed significantly within children free of acoustically perceivable vocal pathologies and with no history of laryngeal health problems. All measurements of optimal pitch (i.e. humming, saying /əhʌm/ and "hello") were significantly higher than measurements of habitual pitch in these children. In addition, spontaneous speech had a significantly lower fundamental frequency than the other two measures of habitual pitch. We conclude that these clinical techniques used to assess optimal pitch may not result in accurate measurements of optimal pitch in children.

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