

A PERIODIC VOCAL FOLD FREQUENCY IN INTERMITTENT APHONIA

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ABSTRACT

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This study analyzes the vocal frequency aspects of the oral reading performance of one "functional" intermittent aphonia client (age 32). The frequency results for the experimental subject are compared with a group of ten normal speaking adults. Frequency measures were determined from Visicorder records.

The results with this one experimental subject indicate the frequency level to be very low (96 Hz) when compared with the results of the group of normal speakers (132 Hz). Wave to wave study of the subject showed the vocal aperiodicity to be concentrated at the onset of upward inflections and at the end of downward inflections. The preponderant aperiodicity in this particular client's reading performance was found to be at lower rather than higher frequency regions.

With this client, it would appear that therapy efforts which attempt to encourage an increase in the frequency level would be substantiated by the data of this study.

A male client, age 32, with unusually severe dysphonia, had been referred to our clinic. The referring otolaryngologist had seen this man over a number of years and had repeatedly observed a very severe, long-standing problem which was diagnosed as "hysterical aphonia". A psychiatric consultation yielded an opinion that the dysphonia was "functional". The otolaryngologist was in accord with the statement of functional etiology; his indirect laryngoscopic examination indicated normal structures. The acoustical measures of this study showed the client's vocal behavior to consist of intermittent periods of short phonation interspersed with whispered vocal efforts and silence. This behavior appears to be the condition which Moore-2 has described as "intermittent aphonia".

In our clinic, the client was given three months of therapy (two thirty minute periods per week) primarily directed toward raising the fundamental frequency level of the client's vocalizations. Unfortunately, no quantitative measure of either the client's frequency level or the amount of aperiodicity was made at the onset of therapy. However, at the end of the three months therapy, in evaluating the therapy procedures, it was apparent that the intermittent aphonia still persisted and the frequency level was still judged to be lower than optimal. It was felt that specific acoustical information might provide a more confident basis for continued therapy.

Staffing consensus was that a detailed acoustic analysis of the client's vocal behavior be instituted. Wave-to-wave measures of the client's reading should determine:

- (1) What were the general fundamental frequency characteristics of this client's voice while reading aloud a standard passage?
- (2) What were the general temporal characteristics of the client's reading performance?
- (3) Were the inflectional patterns (frequency movements) similar to patterns found in a group of normal laryngeal speakers?
- (4) Where was the locus of the client's aperiodicity in relation to inflections?

PROCEDURE

The client was asked to read aloud the Rainbow Passage-2. The client appeared to have normal intelligence; his composite score on the WAIS was 115. The reading ability seemed normal providing consideration was given for the intermittent aphonia. The reading of the passage was recorded at 3 3/4 inches per second on a Sony TC650 and subsequently processed through an oscillographic write-out system (Honeywell Visicorder 906C). For optimum visibility of analysis with this client's reading performance, the Visicorder was operated at a paper speed of 1000 mm per second. The resulting Visicorder tracing was divided into 100 mm. segments (1/10 second) for wave-to-wave inspection and measurement of recurring periodic wave forms. For each interval (i.e., each 1/10 second) a decision was made as to the choice of symbol or measure which best represented that particular individual 1/10 second portion of the entire reading performance. For each interval one of two symbols or a measure was assigned:

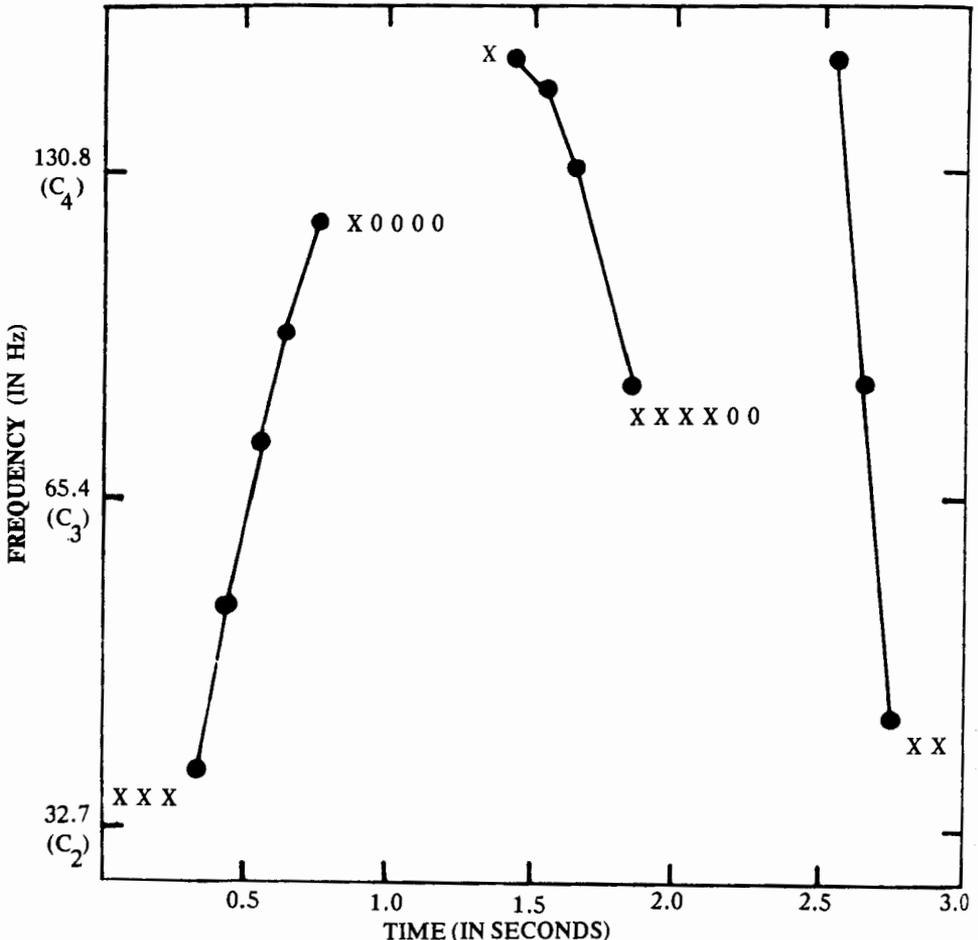


FIGURE 1. SECTION FROM FREQUENCY MOVEMENT CURVE

- PERIODIC PHONATION (39% OF WHOLE VOCAL READING)
- SILENCE OR APHONIA (28% OF WHOLE VOCAL READING)
- X APERIODIC PHONATION (33% OF WHOLE VOCAL READING)

- (1) In a segment with recurring periodic forms, the mean measured periodic value for that 1/10 second segment was determined and plotted on a frequency movement curve. (See typical plot illustrated in Figure 1). The measured values from the Visicorder write-out were in mm. These mm. values were converted to the corresponding frequency for the plot of Figure 1.
- (2) In a segment containing no apparent vocal fold activity (resulting from either a period of silence in the reading, or possibly from actual aphonia with the client), a symbol "O" was assigned and subsequently indicated in the frequency movement curve. (See Figure 1 for sample taken from the frequency movement curve in this study.)
- (3) In some segments, there was obviously phonatory activity, however, without measurable recurring periodic form. In such an interval, a symbol "X" was assigned (see Figure 1).

Table I. Frequency and temporal characteristics of "Intermittent Aphonia" Client and Group of Normal Speakers.

	Intermittent Aphonia Client		Ten Normal Speakers (Group Mean)	
Median Fre- quency Level	96Hz		132 Hz	
Total Reading Time	22.8 sec.		17.4 Sec.	
Periodic Phonation	8.9 sec.	(39.0 per cent)	13.0 sec.	(74.7 per cent)
Aperiodic Phonation	6.4 sec.	(28.0 per cent)	0.4 sec.	(2.3 per cent)
Silence/Aphonia	7.5 sec.	(32.9 per cent)	4.0 sec.	(23.0 per cent)

The first two questions of this study dealt with the general frequency and temporal measures of the reading of the "Rainbow Passage"; these measures are presented in Table I. The left-hand column lists the median frequency level for the client's reading, 96Hz. This value should be contrasted with the right-hand column where 132 Hz₁ is indicated as the mean for a group of ten normal speakers reading aloud the same passage. The client's performance, in its periodic portions, was found to be 36 Hz lower in frequency than the mean performance value for the normal group. The experimental subject used 22.8 seconds for his reading performance; the mean for the group was considerably less, 17.4 seconds, a 24 per cent shorter reading time. The table also indicates the amount of time (and percentage) spent in periodic phonation, aperiodic phonation, and in silence/aphonia. Of substantial interest is the large amount of time spent in aperiodic vocal efforts, 6.4 seconds (28.0 per cent) for the experimental subject compared to 0.4 seconds (2.3 per cent) as the average amount of time during which the normal speakers showed such aperiodicity.

Table II. Frequency Movement and Aperiodicity Characteristics of "Intermittent Aphonia" Client and Group of Normal Speakers.

	Intermittent Aphonia Client	Normal Speaking Group
Total Upward and Downward Inflections		
Number	72	
Mean Extent (tones)	4.03	2.0
Upward Inflections		
Number	33	
Percent of Total Infl.	45.8	31.0
Mean Extent (tones)	4.23	1.8
Duration (secs.)	3.6	
Percent of Total Infl. Dur.	40.9	
Aperiodicity		
Number of Upw. Infl. initiated with aper.	7	
Percent of Upw. Infl.	21.2	
Duration (secs.)	2.3	
Number of Upw. Infl. terminated with aper.	9	
Percent of aper. assoc. with Upw. Infl. at init. of inflections	63.9	
Percent of aper. assoc. with Upw. Infl. at term. of inflections	36.1	

Downward Inflections	Intermittent Aphonia Client	Normal Speaking Group
Number	39	
Percent of Total Infl.	54.2	69.0
Mean Extent (tones)	3.85	2.2
Duration (secs.)	2.8	
Percent of Total Infl. Dur.	59.1	
Aperiodicity		
Number of Downw. Infl. in- itiated with aper.	8	
Percent of Downw. Infl.	20.5	
Duration (secs.)	1.0	
Number of Downw. Infl. terminated with aper.	10	
Percent of Downw. Infl.	25.6	
Duration (secs.)	1.8	
Percent of aper. assoc. with Downw. Infl. at init. of inflec- tions	36.2	
Percent of aper. assoc. with Down Infl. at term. of inflections	63.8	

The third question was concerned with the patterns of frequency movement. For normal speakers, the usual pattern of fundamental vocal frequency in speaking is **upward** by shifts (i.e., frequency movements between phonations) and **downward** by inflections (i.e., frequency movements during phonations). Inspection of Table II indicates the number and extent of upward and downward inflections. In the group of ten normal speakers shown in Table II, 31 per cent of the inflectional movements were upward (average extent of 1.8 tones). However, the experimental subject had 46 per cent of his inflections upward with a much greater mean extent (4.23 tones) than that for the normal group. These measures indicate that the voice of the experimental subject in his reading had roughly an equal number of upward and downward inflections. This is substantially different vocal behavior than that exhibited by the normal speaker group where downward inflections clearly predominate. An inspection of both upward and downward inflection data indicates that the experimental subject has much greater extent of inflections than do the group of normal

speakers with whom he is contrasted. Therefore, one of the conclusions which may be drawn from Table II is that the frequency movement and extent of inflection patterns are distinctly different in the experimental subject and in the group of normal speakers.

The fourth question was concerned with determining the location of aperiodicity in the client's performance with relation to the frequency movements of this speaking. Let us examine first the aperiodicity associated with the upward inflections. These upward frequency movements constitute 45.8 per cent (33 of 72) of the total number of inflectional movements during the client's reading of the standard passage. Seven of these upward inflections (21.2 per cent) were initiated with aperiodicity; whereas, nine (27.3 per cent) of these same upward inflections were terminated with aperiodicity. However, the segment-by-segment measurements showed greater duration of the total initial aperiodicity 2.3 seconds (63.8 per cent), contrasted with 1.3 seconds (35.1 per cent) of total terminal aperiodicity. In the instance of these upward inflections, with upward frequency movement and consequent increase in vocal fold tension, the gross measured amount of aperiodicity decreases.

Let us now examine the aperiodicity associated with the downward inflections. Downward frequency movements constitute 54.2 per cent (39 of 72) of the inflectional movements during the client's reading performance. Eight (20. per cent) of these downward movements were begun with aperiodic vibration, while ten (25.6 per cent) of these downward movements were terminated with aperiodicity. The total duration of terminal aperiodicity was much greater, 1.8 sec. (64.9 per cent), than total initial aperiodicity which lasted for 1.0 second (36.2 per cent) in these downward inflections.

These observations on both types of inflections can be summarized in another way. With either upward or downward inflection, apparently the aperiodic vibration increases as the vocal fold tension decreases (that is, decrease in rate of vibration of the vocal folds). At least with the experimental subject, the increase in tension assumed to be associated with upward frequency movement, resulted in a decreased proportion of aperiodic vibration. The converse was also true. That is, as the vocal fold tension decreased and the frequency went down, aperiodicity increased.

If this analysis is correct, then a decrease in vocal fold tension tends to result in greater aperiodicity. The perponderant aperiodicity in the client's reading performance was determined to be at lower rather than higher frequency regions on the frequency movement plot.

SUMMARY

- (1) The median vocal fold vibration frequency measured for this intermittent aphonia client was 96 Hz; the group of ten normal speaking individuals had a mean value of 132 Hz. The client's performance represents a very low vocal frequency when compared with the normal group.
- (2) The client's reading performance was relatively slow, 22.8 seconds compared with 17.4 seconds for the laryngeal speaker group.
- (3) The experimental subject exhibited 6.4 seconds (28.0 per cent) of aperiodic phonation; this contrasts with 0.4 second (2.3 per cent) for the group of normal speakers.
- (4) The client's aperiodic phonation tended to appear more often in the portions of the performance where the vocal frequency was low rather than high.

(5) Since both the abnormally low median frequency and the location of most of the aperiodicity seem associated with low rather than high vocal fold vibration frequency, therapy efforts which attempt to encourage this client to raise his fundamental frequency level would seem to be substantiated by this study.

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