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Speaking and Singing: How Speaking on One's Optimal Pitch Affects the Singing Voice

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SENIOR THESIS APPROVAL SHEET

This Honor's thesis entitled

"Speaking and Singing: How Speaking on One's
Optimal Pitch Affects the Singing Voice"

written by

Cindy Hood

and submitted in partial fulfillment of the

requirements for completion of the

Carl Goodson Honors Program

meets the criteria for acceptance

and has been approved by the undersigned readers

Thesis Director

Second Reader

Third Reader

Director of the Carl Goodson Honors Program

April 15, 1994

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Carol Morgan: Instructor in Speech Pathology

Dr. Sim Flora: Assistant Professor of Music

Mary Shambarger: Professor of Music

Dr. George Keck: Professor of Music

Dr. Scott Duvall: Director of the Carl Goodson Honors Program
Assistant Professor of Religion

INTRODUCTION

The fields of vocal pedagogy and speech pathology are often thought to be completely separate entities. This misconception has existed for decades and continues to inhibit the vocal growth of the voice student. The student is not permitted to explore the benefits that could come from a combined application of the two fields of study. This is due to the fact that a large number of voice teachers refuse to acknowledge that the scientific study of speech pathology even remotely applies to the study of the "singing" voice. Richard Miller (1986) states:

There is a breed of singing teacher that assembles a set of pedagogical expressions, a group of vocalises, and a swatch of repertory that goes on, year after year, without alteration. New information is unwelcome. Such persons assume that they have always known how to teach, or that they carry on the tradition of one of their famous teachers, or that they can deliver to every singer the same technique that they "gave" to the successful pupil who now sings at the Metropolitan Opera House (p. 213).

This attitude allows for little or no change in teaching techniques and, consequently, little or no correction of the misconceptions that are being passed on from one generation of voice students to the next. Perhaps the most common misconception, as previously noted, is the belief that the fields of vocal pedagogy and speech pathology are not related. This assumption can indeed be disputed, for there are several factors that intricately unite these two fields of study.

The commonality of the fields of vocal pedagogy and speech pathology has been explored in the works of James McKinney (1982) who states:

The basic mechanism for speaking and singing is the same, and the physical processes are essentially the same. Speaking and singing share the same breathing apparatus, the same larynx, the same resonators, and the same articulators (p. 169).

From these facts, one can then conclude that "the way in which we speak has a direct and crucial bearing on the way we sing" (Cooper 1979). One must then ask, "What affect *does* the speaking voice have upon the singing voice?"

CHAPTER 1

RATIONALE

In an individual's speaking voice, there exists an optimal pitch within an optimal pitch range. This pitch range is the area in which the voice naturally lies. This area allows for optimal vocal quality, resonance, and comfort when speaking. Unfortunately, a large number of people do not utilize their optimal pitch range. Instead, they speak on an habitual pitch that is either too far above or too far below their optimal pitch. Morton Cooper (1982) states that "misuse of the speaking voice is widespread in our society," and that the "quality of the speaking voice is directly affected by pitch and tone focus" (p. 36). Cooper (1979) further states:

Singers seldom think about the way they speak. When they sing, they use the trained voice which they have developed through coaching and practice, which is fine. But when they start talking, they often use a completely different voice which is causing both their speaking and singing voices to have problems. [Furthermore], all professionals in contact with singers must recognize the relationship between the speaking and the singing voices. They must be aware of the fact that the speaking voice. . .can create functional and psychological havoc in a singing voice (p. 37).

Although several speech pathologists hold this viewpoint, the number of voice teachers who support the above statements appears to be small. If there are voice teachers who do support these findings, few are willing to incorporate them into their voice teaching.

Whether the voice teacher fears that tampering with the speaking voice is harmful, or if he merely "fears the unknown," remains to be seen. Regardless of the reasoning behind this reluctant attitude, further investigation of the role that the speaking voice plays in the development of the singing voice is needed.

PURPOSE AND RESEARCH QUESTIONS

The purpose of this study is to determine how speaking in one's optimal pitch range affects the singing voice. The primary questions to be answered by this study are:

1. What effect does speaking too far above or too far below one's optimal pitch have upon the vocal quality of the singing voice?
2. If an incorrect habitual pitch during speech is corrected, what will be the effect upon the quality of the singing voice?

The sub-question that will be answered on the basis of research findings is:

Are there significant differences between the test results of those who:

1. did not alter their habitual pitch level, thus continuing to speak out of their optimal range?
2. did alter their habitual pitch level, thus speaking within their optimal pitch range?

CHAPTER 2

RELATED LITERATURE

Due to the interdisciplinary nature of this study, use of literature from both the field of speech pathology and vocal pedagogy is needed. In order to begin this study, a foundational knowledge of the basic vocal mechanism is required. A great deal of literature on the basic vocal mechanism exists in both fields of study. One such work is: Normal Aspects of Speech, Hearing, and Language, by Minifie, Hixon, and Williams (1973). This work focuses upon respiratory function in speech, phonation, normal articulation processes, and speech physiology. Another work is that of Winsel (1968). His book, The Anatomy of Voice, discusses the basic vocal mechanism as well as the topics of legato singing, voice failure, and the spoken voice. Yet another work in this area is The Structure of Singing, by Richard Miller (1986). This work deals with the system and art in vocal technique and sets forth a clear description of the vocal mechanism and its workings.

Perhaps one of the greatest works in the study of vocal pedagogy is the book authored by William Vennard (1949), Singing: The Mechanism and the Technic.

Although a few of the ideas set forth by Vennard are somewhat outdated, this mechanistic book served as a forerunner for much of the vocal research that exists today, for William Vennard was one of the first scholars to advocate the application of science to vocal art.

Another body of literature that often advocates combining the science of speech pathology with vocal pedagogy is the journal published monthly by the National Association of Teachers of Singing, the NATS Journal. This journal regularly features articles such as Jean Westerman Gregg's "From Song to Speech," Ingo Titze's "Voice Research," and "The Laryngoscope." These articles deal with issues ranging from articulation to spectrographic analysis of vowel formants. A major contributor of information to the NATS Journal is Dr. Richard Miller. Miller, along with Juan Carlos Franco, Miller's former student and research assistant, strongly advocate the application of scientific research to the teaching of singing.

To summarize the findings of the related literature, it has been documented that:

1. the basic mechanism for speaking and singing is the same (McKinney)
2. application of science to vocal art is indeed necessary (Vennard, Gregg, Titze, and Miller and Franco)
3. the speaking voice can create functional problems in the singing voice (Cooper)

Although there is increasing awareness of the importance of voice science as is evidenced by the convening of voice *scientists* at events such as the Voice Foundation Symposium in Philadelphia, there is still a great need for further study and practical application of this science to the teaching of vocal technique.

Richard Miller and Juan Carlos Franco are furthering the advancement of voice science through their personal research. In addition to their many NATS Journal articles, they have also conducted a study through a Hughes Research Assistantship entitled, Identifying Factors that Contribute to Health in Speaking and Singing, Though Spectral Analysis.^{*} This study is based on the assumption that "vocal health is directly related to vocal abuse. Vocal abuse which leads to pathology stems from violation of the physiologic and acoustic principles which govern the vocal instrument (p. 1)." The experimental design of the study is:

a two-step diagnostic examination of voice production samples:

1. a pedagogical examination of vocal production using recognizable pedagogical systems to determine any sources of vocal abuse. Health consequences were to be inferred from this examination. This tool is limited for "measuring" health but appropriate for the scope of the project.
2. a spectral analysis of the sound produced which includes spectrographic analysis, power spectrum analysis, and power average analysis.

The study by Richard Miller and Juan Carlos Franco is a prime example of productive research in the field of voice science and serves as a general model for the experimental design of this study.

^{*}This study is unpublished but will be submitted for publication at a later date. The information was made available to this author by Juan Carlos Franco at a visit to the Otto B. Schoepfle Vocal Arts Laboratory at the Oberlin Conservatory in July of 1993.

CHAPTER 3

METHODOLOGY

The purpose of this study is to determine how speaking in one's optimal pitch range affects the singing voice. The primary questions to be answered by this study are:

1. What effect does speaking too far above or too far below one's optimal pitch have upon the vocal quality of the singing voice?
2. If an incorrect habitual pitch during speech is corrected, what will be the effect upon the quality of the singing voice?

In order to resolve these questions, an experimental research design was required. The design for this study began with a population of fifty subjects. This population was comprised of both trained singers and untrained singers, male and female, ranging from age eighteen to twenty-four. The qualification for a trained singer was at least two years of private voice study, and the qualification for an untrained singer was fewer than six months of private voice study or no voice study.

The population was then given a test measuring hearing acuity. This test was an audiometric puretone hearing screening that determined hearing acuity at five hundred Hertz, one thousand Hertz, two thousand Hertz, and four thousand Hertz at twenty-five dB HL.

All members of the population who did not pass the puretone screening bilaterally were dropped from the study.

The population was then tested in order to find each subject's habitual and optimal pitches. In order to determine the subject's optimal pitch, two tests were administered (see Appendix B). Using the procedures outlined by Boone and McFarlane (1988), the first test asked the subject to phonate down to the lowest note in his/her register and up to the highest note in his/her register. Once the subject's lowest and highest notes were determined, his/her optimal pitch was calculated by counting the number of full-step musical notes between the two and dividing the total by four, then moving up from the subject's lowest note by this calculated number. For males, this determined the approximate location of their optimal pitch. For females, however, one additional step was required, for the female's optimal pitch is located one or two notes below the pitch determined by the above method (p. 104). Generally, for males around the age of twenty-one, the optimal pitch is C3 (see Appendix C), and for females in the same age group, the optimal pitch is G3 (Boone, 1991 p. 58).

The second test for verifying the subject's optimal pitch required the use of a Visi-Pitch Machine. This tool provided for a significant amount of control in the results that were obtained for each subject, for the machine served as a standardized measurement device. The Visi-Pitch is a diagnostic tool that works on the IBM Computer System and was made available for this study through the Speech Pathology department at Ouachita Baptist University. The Visi-Pitch provided both statistical analysis and sinusoidal analysis and graphing.

The Visi-Pitch was set on the appropriate frequency (filter) range with the format established as follows (see Appendix D):

1. a nine second time display
2. pitch only/ walking
3. normal trigger display

The subject was instructed to hold the microphone to his/her mouth, maintaining a microphone-to-mouth distance of one to one and a half inches. Each subject was then asked to sigh from the top to the bottom of his/her range in a cyclic manner. The computer then calculated the average frequency of this nine second sample. The frequency, recorded in Hertz, was then converted to a musical note value (see Appendix E). The optimal pitch range was determined visually as well by viewing the graph that was produced. Most of the graph consisted of dotted lines which denoted the areas of the voice that were not strongly amplified. The area of the optimal pitch range, however, consisted of lines of a more solid consistency, representing the area of greatest amplification or resonance (see Appendix F). The results of these two tests established the approximate optimal pitch of the subject.

The next step was to establish the habitual pitch on which the subject was actually speaking. There were two tests used to determine this factor as well. Both tests were conducted on the Visi-Pitch Machine with the same format as previously stated. The subject was first asked to count from one to ten into the microphone. The average frequency of the sample was then calculated.

The second test called for the subject to read a standard passage into the microphone (see Appendix G). The average frequency for this exercise was then calculated as well. These numbers were usually close to the same and if they were not, the average of the two was calculated. This frequency was then converted to a musical note value. These two tests accurately determined the subject's habitual pitch level.

The next step was to determine whether the subject was indeed speaking on his/her optimal pitch. Those who were speaking on their optimal pitch were then dropped from the population, for they were not relevant to this study. Thus the population was narrowed to those subjects who did *not* speak on their optimal pitch.

The population was then divided into four sample groups. The first division separated the trained singers from the untrained singers. The next division placed the subjects into either a control group or a treatment group. The samples were as follows:

- Sample A: Untrained control group
- Sample B: Trained control group
- Sample C: Untrained treatment group
- Sample D: Trained treatment group

All four samples were then given a pre-test, using the Visi-Pitch Machine, which evaluated the amount of frequency perturbation (see Appendix H), that is, the variation of frequency from cycle to cycle that is responsible for the perception of a harsh, hoarse, or rough voice quality (Orlikoff and Baken, 1993 p. 147). The amount of perturbation was measured in the phonation of a sequence of notes on the [a] vowel, a sostenuto exercise (see Appendix I), and an agility exercise (see Appendix J).

The sequence of notes was as follows (see Appendix C):

For Males:	For Females:
C3	A3
F3	C4
C4	F4
F4	F5
A4 (optional)	A5 (optional)
	C6 (optional)

To summarize, the pre-test, having already established the subject's range, evaluated the subject's vocal ability in the areas of sostenuto, agility, quality and clarity, and the quality of the phonation of the [a] vowel on different frequencies. The amount of frequency perturbation in the subject's vocal production was indicative of that subject's vocal quality. If the level of frequency perturbation was greater than 1.0, the quality and clarity of tone was quite poor. If the level was less than 1.0 or near zero, the tone was considered of good quality and clarity.

After the pre-test was given to all samples, the treatment period was begun. Samples C and D were asked to either raise or lower their habitual pitches to the correct level during this four week treatment period. This treatment consisted primarily of the development of the mental concept of the optimal pitch to be used. The subject began each day of the treatment period by listening to his/her optimal pitch and speaking a few phrases on this pitch. This allowed the subject to get a "feel" for his/her optimal pitch. The subject then attempted to keep his/her speech level centered around this optimal pitch for the duration of the day. The subject was also asked to keep a record of his daily attempts in the form of a personal journal.

During this four week period, members of the control group, samples A and B, did nothing to alter their habitual pitch levels.

At the end of the treatment period all four samples were given a post-test which was the same evaluation that was used for the pre-test. A comparative analysis of the data was then conducted. The results of this analysis will be examined in a later section of this paper.

Theoretically, there will be a noticeable difference in the level of frequency perturbation that is present in the pre-test results and the post-test results of sample C, and an equally noticeable difference in the results of sample D. There will be a positive net gain for these two sample groups. Samples A and B, however, will show no noticeable difference in the level of frequency perturbation that is present in the results of the pre-test and those of the post-test. There will be no net gain for samples A and B. The observed differences will be due to the specific treatment that is used; thus, the statistical hypothesis that: speaking on one's optimal pitch or in one's optimal pitch range can improve the vocal ability of one who has spoken on an incorrect habitual pitch.

CHAPTER 4

THE STUDY

As previously noted, this study began with a population of fifty subjects. These subjects were then given the hearing screening, resulting in the elimination of two participants from the study due to their failure to respond appropriately to all required frequencies. Thus, the population was decreased to forty-eight. The optimal pitch and the habitual pitch of each subject was then determined. Two more subjects were eliminated at this point, for their test results were distorted due to their intentional use of excessive inflections (both subjects were in the field of drama and confirmed that they did not use their normal speaking voices). The population was then reduced to forty-six subjects.

The next step was to determine who was or was not speaking on his/her optimal pitch by comparing the subject's optimal pitch to his/her habitual pitch. Of the remaining forty-six subjects, only sixteen were speaking on their optimal pitch. These subjects were then eliminated, reducing the population to thirty subjects.

Therefore, approximately sixty-six percent of the population was not speaking on their optimal pitch, further validating the assumption that this occurrence is wide-spread in our society.

The next step in this study was to divide the subjects into the samples A through D. All samples were then given the pre-test. At this point, six subjects were eliminated due to extenuating circumstances that inhibited their participation in the study (time conflicts or illness). Consequently, the population was reduced to twenty-four. Samples A through D then each consisted of six subjects, samples A and B served as the control group and samples C and D served as the treatment group.

In the pre-test, the levels of frequency perturbation were determined. In sample A, the untrained control group, three subjects produced pitches that were below the 1.0 level and three subjects produced pitches that were above the 1.0 level. The numbers were exactly the same for sample C, the untrained treatment group, as well. The results for the sostenuto and agility tests were also relatively the same.

The results for samples B and D, the trained control group and the untrained control group respectively, were exactly the same for the sostenuto test with five subjects falling below the 1.0 level and one subject lying above the 1.0 level. The results of the pitch test and the agility test were also relatively the same.

The similar results that existed between the control and the treatment groups established a level of consistency and equality among each of the samples.

Thus any differences that may have occurred after the treatment period could be attributed to that specific treatment and not to a poorly matched group of samples or a faulty research design. With these conditions clearly noted, the treatment period was then begun.

During the first week of the treatment period, a problem arose. The voice teachers of two subjects in the treatment group were displeased with the students' involvement in this study. The teachers believed that this study would interfere with their teaching methods and that changing the habitual pitch level of the subjects would be detrimental to the students. Due to this expressed concern, both subjects were removed from the treatment group and placed in the control group. This change had no real effect upon the study itself, one subject was classified as an untrained treatment member of sample C and the other as a trained treatment member of sample D. Thus the samples became as follows:

Sample A: untrained control group consisting of seven subjects

Sample B: trained control group consisting of seven subjects

Sample C: untrained treatment group consisting of five subjects

Sample D: trained treatment group consisting of five subjects.

The treatment period was continued as planned, and the subjects in the treatment group were contacted periodically (once each week) to ensure that each was performing the procedures necessary for the treatment.

After the treatment period had ended, all subjects in both the treatment and control groups were given the post-test. The post-test was administered in the same manner as the pre-test, and the results were recorded accordingly. After having re-tested the twenty-four subjects, the results of the evaluations were compared.

CHAPTER 5

THE RESULTS

As previously stated, the primary emphasis of the two tests was upon the perturbation levels that were present in a series of pitches sung on the [a] vowel, a sostenuto exercise, and an agility exercise. A perturbation above the 1.0 level was considered a poor quality tone, and a perturbation below the 1.0 level is considered to be a tone of a better quality. After the pre-test was administered, the perturbation levels of each sample were found to be as follows:

Sample A:

Pitch test: four subjects above 1.0, three subjects below 1.0
Sostenuto test: four subjects above 1.0, three subjects below 1.0
Agility test: five subjects above 1.0, two subjects below 1.0

Sample B:

Pitch test: three subjects above 1.0, four subjects below 1.0
Sostenuto test: one subjects above 1.0, six subjects below 1.0
Agility test: three subjects above 1.0, four subjects below 1.0

Sample C:

Pitch test: two subjects above 1.0, three subjects below 1.0
Sostenuto test: one subject above 1.0, four subjects below 1.0
Agility test: two subjects above 1.0, three subjects below 1.0

Sample D:

Pitch test: four subjects above 1.0, one subject below 1.0
Sostenuto test: one subject above 1.0, four subjects below 1.0
Agility test: two subjects above 1.0, three subjects below 1.0

After the post-test was administered, the perturbation levels of each sample were found to be as follows:

Sample A:

Pitch test: one subject above 1.0, six subjects below 1.0
Sostenuto test: three subjects above 1.0, four subjects below 1.0
Agility test: four subjects above 1.0, three subjects below 1.0

Sample B:

Pitch test: three subjects above 1.0, four subjects below 1.0
Sostenuto test: two subjects above 1.0, five subjects below 1.0
Agility test: five subjects above 1.0, two subjects below 1.0

Sample C:

Pitch test: zero subjects above 1.0, five subjects below 1.0
Sostenuto test: one subject above 1.0, four subjects below 1.0
Agility test: two subjects above 1.0, three subjects below 1.0

Sample D:

Pitch test: one subject above 1.0, four subjects below 1.0
Sostenuto test: zero subjects above 1.0, five subjects below 1.0
Agility test: two subjects above 1.0, three subjects below 1.0

After comparing the results of the pre-test with those of the post-test, the following general differences were noted:

Sample A:

Pitch test: three subjects improved
Sostenuto test: one subject improved
Agility test: one subject improved

Sample B:

Pitch test: zero subjects improved
Sostenuto test: zero subjects improved, one subject declined
Agility test: zero subjects improved, two subjects declined

Sample C:

Pitch test: two subjects improved
Sostenuto test: zero subjects improved
Agility test: zero subjects improved

Sample D:

Pitch test: three subjects improved
Sostenuto test: one subject improved
Agility test: zero subjects improved

The term improved denotes the subject's movement below the 1.0 level of perturbation. The term declined denotes the subject's movement above the 1.0 level of perturbation. For this comparison, the subject was only evaluated on whether or not the perturbation level moved above or below the 1.0 level, not on the degree of the movement.

According to the above definition, five members of the control group and six members of the treatment group improved. The difference between the two groups in this comparison does not seem to be significant.

However, it was also determined that three members of the control group declined, while the members of the treatment group did not. This could possibly indicate that the treatment period did prevent any further decline, and given more time, could have led to further improvements.

A comparison of the overall results for each individual subject was also made. This comparison dealt with the degree that the subject moved above or below the 1.0 level in the pre-test and the post-test results. The subjects who were in the control group demonstrated no significant improvement. Seven subjects made no improvements, while the other seven subjects declined. This decline was marked by an increase in the subjects' perturbation levels. The observed increases ranged from 0.8 to 1.8 percent.

The subjects in the treatment group had very different results from those in the control group. The individual subjects in the treatment group demonstrated slight improvement. Although three subjects had no significant improvement, seven subjects decreased their perturbation levels by 0.1 to 1.5 percent.

CHAPTER 6

CONCLUSIONS, FURTHER ASPECTS, AND IMPLICATIONS

Having completed the comparative analysis of the data, the research questions must be answered. The first of the primary questions, "What affect does speaking too far above or too far below one's optimal pitch have upon the vocal quality of the singing voice?" can be answered by the data found when comparing the results of the control group. Due to the fact that the members of the control group continued to speak out of their optimal pitch ranges, an idea of the effect of an incorrect pitch level upon the voice can be obtained. Since fifty percent of the control group showed no improvement and the other fifty percent declined, it seems that speaking out of one's optimal range can cause an increase in the level of perturbation present in the singing tone. Although half the group was not affected, it is feasible that given a longer period of time, their perturbation levels might have increased as well.

The second of the primary questions, "If an incorrect habitual pitch during speech is corrected, what will be the effect upon the quality of the singing voice?," can be answered by comparing the results of the treatment group. Although three members of the treatment group did not show a noticeable improvement, seven members did improve slightly. These seven members, who comprise seventy percent of the group, decreased the perturbation level in their tones.

Therefore, it can be concluded that correcting an incorrect habitual pitch can decrease the level of perturbation in the singing tone.

The sub-question of this study deals with the comparisons between the control group and the treatment group. The sub-question asks, "Are there significant differences between the test results of those who did not alter their habitual pitch level and those who did alter their habitual pitch level?" Although the differences in the first comparative study were not overwhelming, it is indeed significant that the treatment group had an improvement level that was twenty percent greater than that of the control group. It is also significant that fifty percent of the control group declined, while none of the members of the treatment group did so. Thus, on the average, those subjects who changed their habitual pitch level to their optimal pitch level produced a higher quality tone than those subjects who did not correct their habitual pitches, therefore, proving the hypothesis that speaking on one's optimal pitch or in one's optimal pitch range can improve the vocal ability of one who has spoken on an incorrect habitual pitch.

OTHER ASPECTS OF THE STUDY

Due to the fact that this study dealt with human subjects, there existed many variables which were uncontrollable. It was virtually impossible to eliminate from the testing, factors such as vocal fatigue, lack of vocal warm-up, allergies and other cold symptoms, nervous reactions, and the basic differences that existed in the vocal mechanisms of the different subjects. Although the subjects were monitored, it was also difficult to ensure that all the members of the treatment group were carrying out the treatment procedures.

In fact, most of the treatment group only carried out the procedures for seventy-five percent of the assigned time. Had there been a way in which to monitor the subjects closely for the entire treatment period, the positive effects of the treatment may have been increased tremendously.

Another aspect that must be considered is the duration of the treatment period. Although time constraints did not allow for more time, four weeks was not an ideal time period for this study. It is possible that the members of the treatment group would have made even greater improvements had they been given a longer period in which to work with their optimal pitch.

Although this study was conducted thoroughly and thoughtfully, all conclusions are based on educated speculations and should be viewed as theories awaiting further research and investigation.

IMPLICATIONS

The implications of this study are far-reaching. In a matter of only four weeks, several subjects improved their singing voices by improving the manner in which they spoke. This further supports the belief that speech pathology and vocal pedagogy are indeed related. Further research in this area needs to be conducted. There must also come to exist a greater amount of cooperation between the voice teacher and the speech pathologist. Perhaps one day the traditional method of teaching voice will be obsolete, and a new method that combines the teaching of correct speech with correct vocal technique will soon emerge.

APPENDIX A

CONSENT TO PARTICIPATE IN AN EXPERIMENTAL STUDY

Title: Speaking and Singing: How Speaking in One's Optimal Pitch Range Affects the Singing Voice

Investigator: Cynthia F. Hood
Honors Senior Thesis Plan
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Second Reader: Mary Shambarger
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Description. Speaking in one's optimal pitch range can improve one's vocal ability in singing.

Risks. There is no anticipated physical nor mental risk associated with the participation in this study as outlined hereafter.

Confidentiality. Any information obtained about you from this research, including history, singing ability, or physical measures, will be kept strictly confidential. When the study results are published, they will be made anonymous and/or disguised so that identification cannot be made.

Right to Withdraw. You are free to refuse to participate in this study or to withdraw from the study at any time. Your decision will not adversely affect your status with the University.

Participation will involve both trained and untrained singers. Each singer will be given a pre-test to determine vocal ability. The evaluation will be as follows:

1. Vowel formation and quality. Using predetermined measures of vowel formants, a comparison of the subject's vowel production to textbook charts of spectrographic analysis will be completed.
2. Agility. The subject's ability to move the voice rapidly through several pitches will be determined.
3. Sostenuto. The subject's ability to sustain long notes and move from pitch to pitch in a legato manner will be determined.
4. Range. The lowest and highest singable tones of the subject will be determined.
5. Resonance and quality. The overall resonance and quality of the subject's vocal tone through spectrographic analysis of the singing of a given phrase will be determined.
6. Hearing acuity. Each singer will be given an audiometric puretone hearing screening to determine hearing acuity at 1000 Hertz, 2000 Hertz, and 4000 Hertz at 25dB HL.

Voluntary Consent. I certify that I have read the preceding or it has been read to me, and that I understand its contents. I acknowledge that I have been given the opportunity to ask questions regarding the study and that questions I asked were fully answered. I understand that further questions will be answered by Nancy J. Turner, Carol W. Morgan, Mary Shambarger, or Cynthia Hood. I understand that a copy of this consent form will accompany the completed research project. I further release liability from Ouachita Baptist University and aforementioned persons involved in this study. My signature below means that I freely agree to participate in this experimental study and that my signature was not gained by any threat, coercion, or undue influence made against my person.

Dated this _____ day of _____, 199__.

Participant Signature

APPENDIX B

NAME:_____ AGE:_____

BOX #:_____ PHONE #:_____

CHECK ONE:

I HAVE STUDIED VOICE PRIVATELY:

- NEVER
- LESS THAN SIX MONTHS
- BETWEEN SIX MONTHS AND ONE YEAR
- BETWEEN ONE AND TWO YEARS
- MORE THAN TWO YEARS

DO NOT WRITE BELOW THIS LINE

HEARING: RIGHT_____ LEFT_____

OPTIMAL PITCH RANGE:

LOWEST NOTE:_____ HIGHEST NOTE:_____

AV. FO:_____ MIN. FO:_____ MAX. FO:_____

OP: FREQUENCY_____ NOTE_____

HABITUAL PITCH RANGE:

READING #1:

AV. FO:_____ MIN. FO:_____ MAX. FO:_____

READING#2:

AV. FO:_____ MIN. FO:_____ MAX. FO:_____

HP: FREQUENCY_____ NOTE_____

APPENDIX C

PIANO KEYBOARD:



Sex and Age and Natural Pitch Level

Babies, 10 months old
 Boys and girls, age 9
 Women, age 21
 Women, age 51
 Men, age 21
 Men, age 51

HZ

400 Hz
 260 Hz
 195 Hz
 175 Hz
 130 Hz
 110 Hz

Musical Note

near G⁴
 near C⁴
 near G³
 near F³
 near C³
 Near A²

APPENDIX D

APPROPRIATE RANGE SETTING

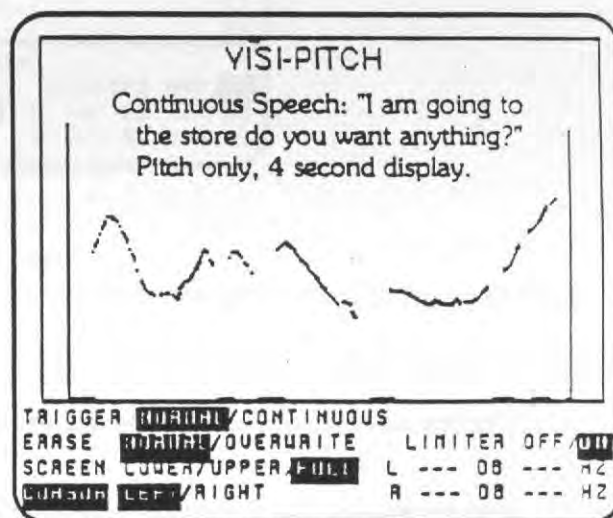
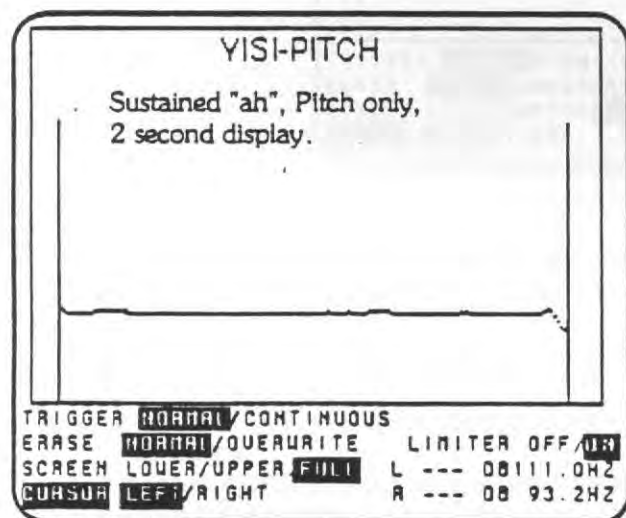
The range setting simply makes the Visi-Pitch sensitive to the various fundamental frequencies produced by different speakers. A general good rule to follow is:

- Range A: Most male speakers.
- Range B: Some male speakers, some female speakers and some young adults.
- Range C: Some female speakers, many children.
- Range D: Infant cries or professional singers.

NOTE: The range buttons are found on the front panel of the Visi-Pitch 6087DS and the 6095. The user should select the range (A-D) that is appropriate for the fundamental frequency that they intend to analyze. In some cases (initial evaluation), the user must estimate the frequency range of the individual and/or experiment with which range tracks the voice the best (e.g., sometimes a female voice will track better on Range C than on Range B).

The SELECT RANGE SETTING from the MAIN MENU controls the frequency scale that will be displayed on the Apple Screen and is independent of the frequency filter range button on the Visi-Pitch panel (see Visi-Pitch Operations Manual for further explanation).

A good microphone position, using the appropriate range for a normal healthy voice should yield displays like these:



If your traces do not look like these, experiment with microphone position and/or range selection.

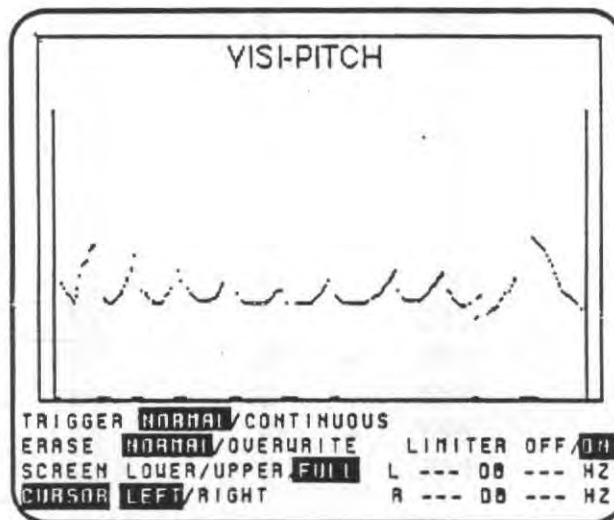
HABITUAL PITCH: COUNTING

(Pitch Only, 8 Sec., Full Screen)

Measures of Habitual Pitch continue by having the client recite a common phrase or counting one to ten. Set the Visi-Pitch as follows:

- On the MAIN MENU, use the down arrow key to highlight the SELECT TIME DISPLAY and press RETURN.
- Highlight the 8 SECONDS option and press RETURN to bring up the MAIN MENU.
- Highlight the SELECT DISPLAY FORMAT and press RETURN. *Intensity*
- Use the down arrow key to choose the PITCH ONLY WALKING display and press RETURN.
- With the BEGIN TAKING DATA highlighted on the MAIN MENU press RETURN.

Instruct the client to hold the microphone close to the mouth and count one to ten. A normal display should look like this:



To calculate statistical information on the vocalization:

- Select the CURSOR function from the text at the bottom of the screen by using the up or down arrow key.
- Press the L key to activate the left cursor and use the right arrow key to mark the beginning of the utterance.
- Press the R key to activate the right cursor and use the left arrow key to mark the end of the utterance.
- Press RETURN to bring up the MAIN MENU.
- Use the down arrow key to highlight the CALCULATE STATISTICS and press RETURN.

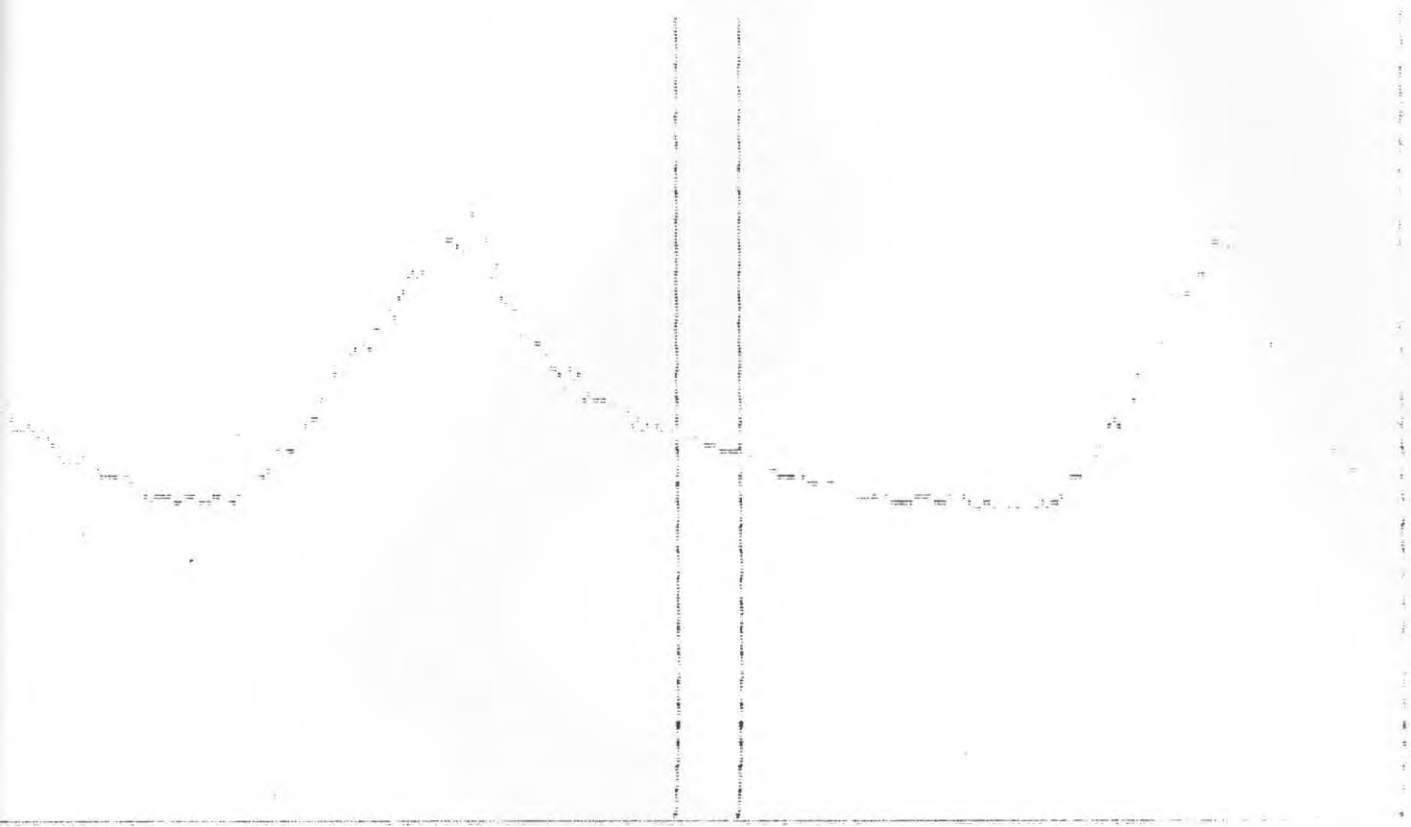
APPENDIX E

MUSICAL NOTE TO FREQUENCY CHART

NOTE	FREQ. (Hz)	NOTE	FREQ. (Hz)	NOTE	(FREQ.)
A ₃	- 55	A ₁	- 220	A ¹	- 880
B ₃	- 62	B ₁	- 245	B ¹	- 988
C ₂	- 65	C ₁ (old)	- 262	C ²	- 1046
D ₂	- 73	D	- 294	D ²	- 1175
E ₂	- 82	E	- 330	E ²	- 1318
F ₂	- 87	F	- 349	F ²	- 1397
G ₂	- 98	G	- 392	G ²	- 1568
A ₂	- 110	A	- 440	A ²	- 1760
B ₂	- 123	B	- 494	B ²	- 1975
<i>Average for men age 21</i> C ₁	- 131	C ¹	- 523	C ³	- 2093
D ₁	- 147	D ¹	- 587	D ³	- 2349
E ₁	- 164	E ¹	- 659	E ³	- 2637
F ₁	- 175	F ¹	- 698	F ³	- 2794
<i>Average for women age 21</i> G ₁	- 196	G ¹	- 784	G ³	- 3136

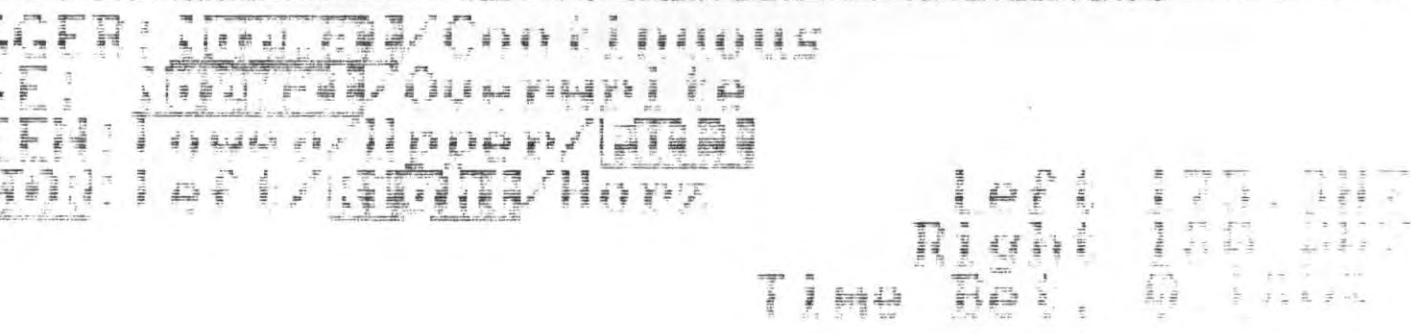
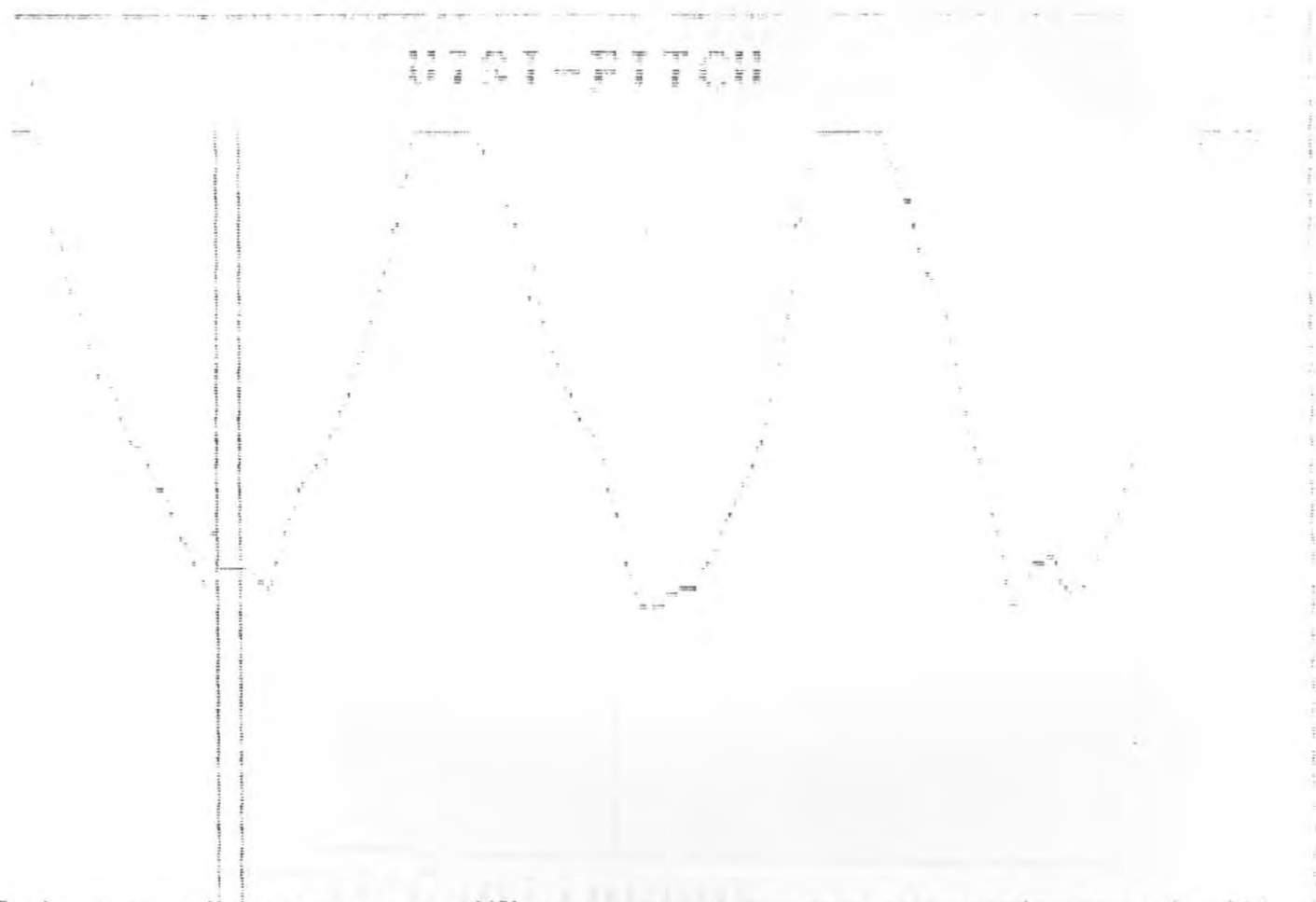
NOTE: All decimals are rounded off. The U.S. Pitch will only record between 0 - 1600 Hz.

1000
900
800
700
600
500
400
300
200
100
0



1000
900
800
700
600
500
400
300
200
100
0

1000
900
800
700
600
500
400
300
200
100
0



APPENDIX G

MY GRANDFATHER

You wished to know about my grandfather. Well, he is nearly ninety-three years old; he dresses himself in an ancient, black frockcoat, usually minus several buttons; yet, he still thinks as swiftly as ever. A long flowing beard clings to his chin, giving those who observe him a pronounced feeling of the utmost respect. When he speaks, his voice is just a bit cracked and quivers a trifle. Twice each day he plays skillfully and with zest upon our small organ. Except in the winter when the ooze or snow or ice prevents, he slowly takes a short walk in the open air each day. We have often urged him to walk more and smoke less, but he always answers, "Banana Oil!" Grandfather likes to be modern in his language.

Reading passages, such as "My Grandfather" (Van Riper, 1963), are often used to obtain speech samples in screening programs for older individuals (Emerick and Haynes, 1986).

APPENDIX H

PITCH PERTURBATION (JITTER)

(Pitch Only, 6 or 8 Sec., Full Screen)

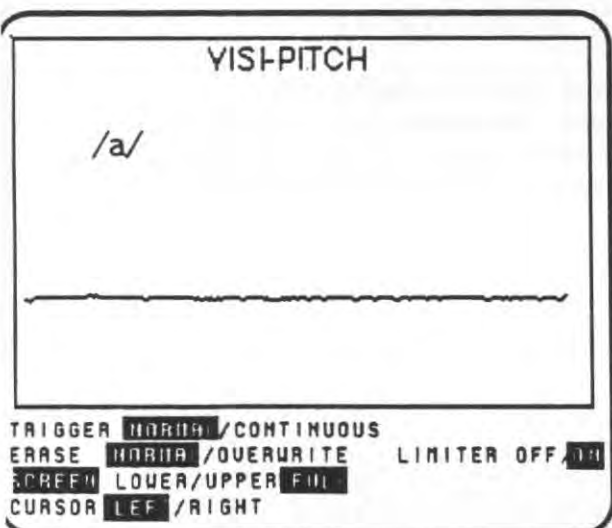
Pitch perturbation can be described as a measure of cycle to cycle variations in pitch. Perturbation can also be used to quantify the cycle to cycle differences (perceptually described as roughness) in a vocalization. There are at least five different formulas for calculating pitch perturbation. The Visi-Pitch uses Koike's Formula for calculating Relative Average Perturbation (RAP).

Listed below is a suggested method of obtaining and measuring pitch perturbation with the Visi-Pitch. The user should be careful to follow this procedure closely to insure reliability and repeatability so that patient performance can be compared from session to session.

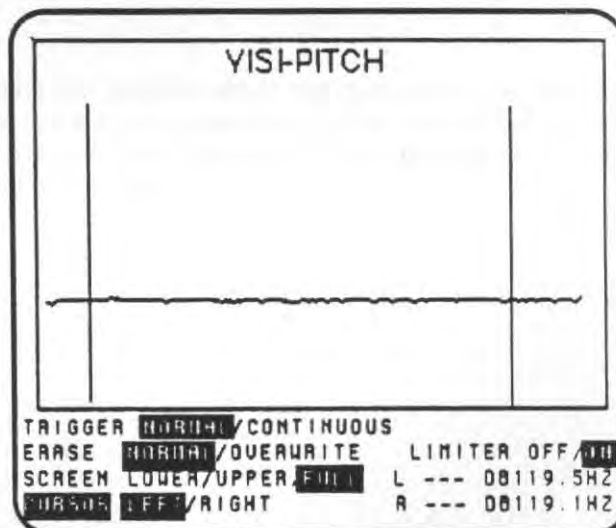
- Choose the appropriate Frequency Filter Range on the Visi-Pitch front panel.
- On the MAIN MENU, highlight the SELECT TIME DISPLAY and press RETURN.
- Choose either the 6 or the 8 SECONDS option and press RETURN.
- Select the SELECT DISPLAY FORMAT on the MAIN MENU and press RETURN.
- Highlight either the PITCH ONLY STATIONARY or PITCH ONLY WALKING DISPLAY and press RETURN.
- With the BEGIN TAKING DATA option highlighted on the MAIN MENU press RETURN.

Instruct the client to hold the microphone close to the mouth (1" to 1-1/2" maximum) and sustain phonation of a neutral vowel (e.g., /a/).

A client with a normal, healthy voice will be able to generate a thin trace, flat in contour, illustrating his/her capability to produce a steady frequency without pitch breaks. A normal voice should look like this: To make reliable perturbation measurements:

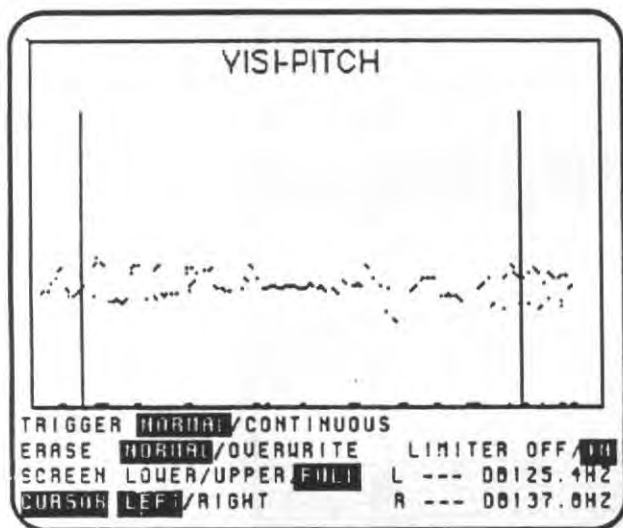


Pitch Trace of Normal Voice



Cursor Placement for Perturbation Measurement

The Statistical page will appear on the screen. Normal values of pitch perturbation using Koike's Formula are approximately 1.00% and below. The "norami voice" trace shown on the preceding page had a perturbation value of .33%. The figure below illustrates a pathological voice, exhibiting a high degree of pitch perturbation (3.91%).



Pitch Trace of Pathological Voice

STATISTIC	COL #1	COL #2	CHANGE
VALUES ARE FOR ALL DATA BETWEEN CURSORS			
AVERAGE F0	129.7	---	--- HZ
EXTENDED AV. F0	---	---	--- HZ
AVERAGE DB	---	---	--- DB
TIME BET. CURSORS	2.272	---	--- S
PERTURBATION	3.91	---	--- %
MAXIMUM F0	155.6	---	--- HZ
MINIMUM F0	79.9	---	--- HZ
F0 RANGE	75.7	---	--- HZ
F0 AT L	125.4	---	--- HZ
F0 AT R	137.8	---	--- HZ
INTENSITY AT L	---	---	--- DB
INTENSITY AT R	---	---	--- DB
TO PRINT THIS SCREEN PRESS <input type="checkbox"/> P			
NEXT SET OF STATISTICS WILL BE IN COL 1			
COL #1	---	---	CURRENT INPUT DATA
COL #2	---	---	
---	COLUMN	---	<input type="checkbox"/> RETURN FOR OPTIONS

Abnormally High Perturbation

Microphone and cursor positioning are variables which can significantly influence the accuracy of the perturbation measurement. Because this is such a sensitive measure, values that are close to normal limits (i.e., 1.25%) should be retaken by the clinician to determine if the voice quality and measurement technique produce consistent results from trial to trial.

APPENDIX I

Voice

Sing — le - ga - to,

Piano

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APPENDIX J

Voice

Flex - i-bil-i - ty, flex - i-bil-i - ty,

Piano

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GLOSSARY

- agility:** ability to move the voice rapidly from note to note.
- articulators:** the tongue, the lips, the teeth, the soft palate, and the hard palate, which modify the acoustic properties of the vocal tract.
- bilaterally:** in both ears.
- breathing apparatus:** consists primarily of the diaphragm, the lungs, and the intercostal muscles.
- clarity:** a low level of perturbation.
- formant:** partials of a vocal tone that determine the characteristic quality of a vowel; partial tones originated by action of the breath on the resonance chambers that have regions of prominent energy distribution.
- Hertz:** in acoustics, a measure of frequency equal to one cycle per second and named after the German physicist Heinrich R. Hertz (1857-94).
- laryngoscope:** a device for examination of the larynx.
- larynx:** forms the uppermost unit of the trachea or windpipe. its primary purpose is to serve as a valve which keeps food, drink, and other foreign matter out of the lungs and which holds breath in the lungs to assist in singing.
- legato:** [It., bound]. Sung smoothly with no separation of notes.
- phonation:** the process of voicing; sounds produced by the vocal folds.
- range:** the span of pitches between highest and lowest of an instrument, voice, or part.

resonators: areas that enhance the basic product of phonation by adding amplification, enrichment, and enlargement to the tone. The vocal resonators are: the chest, the tracheal tree, the larynx, the pharynx, the oral cavity, the nasal cavity, and the sinuses.

sostenuto: the sustaining of the singing voice.

spectrograph: apparatus for photographing the spectrum; photograph or picture of a spectrum.

spectrum analyzer: a device that displays the relative amplitudes of all the overtones of the voice in a phonation; vowel definition is shown as spectral peaks, and the singer's formant is displayed as a region of strong acoustic energy.

speech pathology: the profession that specializes in diagnosis and treatment of speech and language problems, and engages in scientific study of human communication; may direct scientific projects investigating biophysical and biosocial phenomena associated with voice, speech, and language.

vocal pedagogy: the art, profession, or study of the teaching of singing and the vocal mechanism as it pertains to singing.

vocalises: singing without text, often for didactic purposes or to warm up before performance, thus often arpeggios or other exercises.

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