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The Relationship Among Nasality Ratings of Single Words, Phrases, and Running Speech Samples Obtained from Cleft Palate Children

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To the Graduate Council:

I am submitting herewith a thesis written by Hal Jefferson Daniel entitled "The Relationship Among Nasality Ratings of Single Words, Phrases, and Running Speech Samples Obtained from Cleft Palate Children." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Speech Pathology.

Harold L. Luper, Major Professor

We have read this thesis and recommend its acceptance:

Carl N. Pop, Eugene E. Doll

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

May 11, 1967

To the Graduate Council:

I am submitting herewith a thesis written by Hal Jefferson Daniel III entitled "The Relationship Among Nasality Ratings of Single Words, Phrases, and Running Speech Samples Obtained from Cleft Palate Children." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Speech Pathology.

Harold L. Luper
Major Professor

We have read this thesis and recommend its acceptance:

Carl H. Hop

Eugene F. Doll

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THE RELATIONSHIP AMONG NASALITY RATINGS OF SINGLE WORDS, PHRASES, AND RUNNING SPEECH SAMPLES OBTAINED FROM CLEFT PALATE CHILDREN

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

Hal Jefferson Daniel III

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

This study is concerned with the relationships between ratings of nasality of cleft palate children while speaking structured words and structured phrases and the nasality ratings of the children speaking unstructured running speech.

I. THE PROBLEM

Statement of the problem. This study was designed to determine the relationships among the nasality ratings of structured single words, structured three-word phrases, and of unstructured running speech samples obtained from a group of cleft palate children. More specifically, the purpose of the experiment was to determine if nasality ratings on structural single words and on structured three-word phrases were related to the nasality ratings obtained from samples of unstructured running speech.

Importance of the study. It was anticipated that the results of this study would elicit information needed for

the establishment of a specific word and/or phrase test for screening overall nasality. This information should be valuable to the speech pathologist and the physician. Hypernasality, a relative term based upon the presence of nasal voice quality of an individual subject, is frequently associated with cleft palate speech. One of the primary criteria for determining the success of surgical closure of the palate is the absence of or a reduction in the subject's nasal voice quality following the operation.

The assessment of nasality in speech is largely a subjective evaluation. The speech pathologist or physician ideally would like to know the degree of the subject's nasal voice quality in normal everyday speech situations. Therefore, the need for a short screening test which is indicative of the nasality in conversational unstructured speech situations is obvious. At present no study has reported any data on the relationships of nasality ratings on structured single words, structured three-word phrases, and unstructured running speech. The present study was designed to investigate the possible differences and relationships among these three types of speech samples.

II. DEFINITION OF TERMS USED

Several terms used throughout this text require further explanation. These terms are defined as follows:

Structured single words. A list of six words was selected for obtaining single word speech responses from the subjects in this study. These words were structured to contain the following consonant and vowel phonemic units: (p), (t), (k), (θ), (s), (ʃ), (i), and (u).

Structured phrases. A list of three-word phrases, including all of the structured single words and connected by the necessary parts of speech, was prepared for use in this study.

Unstructured running speech. For the purposes of this study, unstructured running speech was defined as a speaking situation in which the subject was asked to tell a story.

Nasality. (Hypernasality.) Johnson (1956) defined nasality "as a voice quality which is perceived by a listener as speech that sounds as if the person is talking

through his nose." The transmission of sound through the nose is thought to be due to failure of the soft palate and/or the walls of the nasopharynx to perform their usual function of shutting off the upper part of the pharynx and the upper part of the nasal cavities during the production of nonnasal sounds.

III. HYPOTHESIS

This study was designed to test the following hypothesis, stated in null form:

In terms of nasality ratings, there is no significant difference among ratings of structured single words, structured three-word phrases, and unstructured running speech samples.

CHAPTER II

REVIEW OF THE LITERATURE

The stimuli and recording procedures within the study were chosen on the basis of the literature reviewed, which was divided into two groups. The first, that relating to the articulatory patterns of cleft palate speakers, suggested that certain types of phonemic units have the greatest possibility of being misarticulated. The second, which deals with estimates of nasality in cleft palate speakers, indicated that those vowels with the highest tongue placement have the greatest possibility of becoming nasalized. In addition, certain selections from the second group point to the fact that the most valid ratings of nasality can be made from speech samples that are played backwards.

I. ARTICULATORY PATTERNS OF CLEFT PALATE SPEAKERS

Several studies have investigated the type of phonemic unit most often found defective in cleft palate speech. Subtelny and Subtelny (1959) reported from a study of 27 cleft

palate subjects that plosive type phonemic units tend to be misarticulated due to the poor velopharyngeal closure of the cleft palate subjects. West, Kennedy, and Carr (1947) indicated that the plosives are the most seriously defective sounds in cleft palate children in terms of articulation. Pitzner and Morris (1966) confirmed that cleft palate children display poor articulation skills on plosive and fricative type phonemic units. In a study of the articulation skills of children with cleft palates, Byrne, Shelton, and Diedrich (1961) supported the observations by also concluding that speakers with cleft palates have the greatest articulatory difficulty with fricative and plosive sounds.

Spriestersbach, Moll, and Morris (1961) demonstrated that the ability to impound intraoral pressure is an important factor in the articulatory proficiency of children with cleft palates. In two earlier studies Hudgins and Stetson (1935) and Black (1950) have shown that oral breath pressure during the production of fricatives and plosives is greater than on any other type of phonemic unit. Spriestersbach and Powers (1959) stated:

> Investigators such as Bzoch, Counihan, McWilliams, Spriestersbach and others, and Starr have found that

> cleft palate speakers misarticulate with greatest frequency those sounds for which oral breath pressure is highest for normal speakers.

Morris, Spriestersbach, and Darley (1961) found in a study of good and poor velopharyngeal closure groups that fricatives and plosives give the poor closure groups the greatest degree of articulation difficulty. These authors also maintain that the position of the sound element in the test word apparently has no differential discriminatory effect on the articulatory performances of individuals with adequate and inadequate closure.

A number of investigators have given their attention to the functions of certain specific plosive and fricative type phonemic units in cleft palate speech. Berry (1949) wrote that (t), (s), and (ʃ) were found to be defective in children with palatal clefts, because the tongue did not make the proper articulatory adjustments. Eckelman and Baldridge (1945) stated that the following sounds are likely to be distorted or replaced by other sounds in cleft palate children: (p), (t), (s), (ʃ), (θ), and (k). Spriestersbach, Darley, and Rouse (1956), in a study of 25 cleft lip and/or cleft palate children, reported that the following phonemes

were misarticulated more than 60 percent of the time: (z), (θ), (s), (ʒ), (ð), (ʃ), and (t).

Elsewhere in the study by Spriestersbach, Darley, and Rouse (1956), it was reported that cleft palate children had more articulation problems with voiceless consonants than voiced consonants and extreme difficulty in the articulation of the fricative type phonemic units. Similarly, Spriestersbach, Moll, and Morris (1961) have stated that:

> Counihan and McWilliams studied adolescent cleft palates for whom the period of articulation development was presumably completed. For their subjects the voiceless sounds were more defective than the voiced sounds for the fricative as well as the plosive phonemic units.

II. ESTIMATES OF NASALITY OF CLEFT PALATE SPEAKERS

Various studies have dealt with the relationship between articulation proficiency and nasality ratings in cleft palate speech. Counihan (1960) concluded from a study of the articulation skills of cleft palate speakers that nasal emission appeared to be a significant factor in their misarticulations. Van Hattum (1958) reported that judgments of the degree of nasality in connected speech tend to vary

with judgments of nasality on isolated vowels but that "the relationship is not strong enough for one measure to be useful in predicting the other."

Although Van Hattum's study indicates little relationship between articulation proficiency and nasality ratings, Spriestersbach and Powers (1959a) criticized his study on the grounds that the articulatory proficiency of a subject affects the rating of nasality assessed to that subject. Sherman (1954) indicated that playing speech samples backwards eliminated irrelevant factors which might influence the observers' assessment of nasality. She concluded that scale values of severity of nasality obtained from judgments of speech samples played backwards are more valid than scale values obtained when samples are played forwards. Spriestersbach (1955) used two groups of auditors, one judging nasality with tapes played forward and the other group judging the same tapes played backwards. He found that judgments of severity of nasality in the speech samples presented forward were significantly related to effectiveness of pitch variation and defectiveness of articulation, while judgments of severity of nasality of the speech samples played backwards were not significantly related to these variables. He

were not significantly related to these variables. He concluded that

> . . . judgments of the severity of nasality of the speech samples presented backward would appear to be more valid than those made when speech samples are presented forwards.

Van Demark (1964) also employed Sherman's technique of playing speech samples backward to reduce the possibility of listeners making judgment errors due to misarticulations by the speaker.

Utilizing the procedure suggested by Sherman, Spriestersbach and Powers (1959a) reported from a study of nasality in isolated vowels and connected speech of cleft palate speakers that the severity of nasality while phonating the vowels with the highest tongue placement, more specifically (i) and (u), was significantly related to the severity of nasality in connected speech. In a study of phonectic elements and nasality perception, Lintz and Sherman (1961) stated that where adequate closure is a problem, as is likely with cleft palate speakers, it would be expected that high vowels would be perceived as more severely nasal than low vowels. This is due to the fact that high vowels require "complete" closure for nonnasal production. These

authors indicated that perceived nasality increases in severity for cleft palate speakers from low to high vowels with (ɑ) the least nasal and the vowels (i) and (u) the most nasal.

In summary, evidence in the literature indicated that voiceless plosive and fricative phonemic units have the greatest possibility of being misarticulated and that the vowels with the highest tongue placement, (i) and (u), have the greatest possibility of becoming nasalized. It may also be stated that the most valid ratings of nasality can be made from speech samples that are played backwards.

CHAPTER III

METHODS AND PROCEDURES

The present study was undertaken to determine the relationships among nasality ratings of structured single words, structured three-word phrases, and unstructured running speech samples spoken by a group of cleft palate children. Judgments of nasal voice quality were obtained by having listeners rate selected recorded speech samples of each subject. The scale values of nasal voice quality for each subject in the three conditions were compared.

I. SUBJECTS

Several criteria were used in the selection of subjects. The subjects for this study were cleft palate children who had received service from the Cripple Children's Service Plastic Surgery Clinic in Knoxville, Tennessee. It was required that all children be at least three years of age since Templin (1959) has observed that by three years of age children's utterances begin to conform to the grammatical structure of a language. No child was used if a hearing

loss of 25 decibels or more in the speech frequencies (500, 1000, 2000 Hz.) was observed. It was further required that all children make oral responses to all stimuli presented to them within the study.

The test group consisted of 15 children who met the above mentioned criteria. This group consisted of eight males and seven females between the ages of 6 and 17. The mean age for the group was 9.3 years.

II. TESTS, TESTING INSTRUMENTS, AND SETTING

Each subject was given a screening pure-tone audiometric test using the frequencies 500, 1000, and 2000 Hz. to eliminate those subjects falling below 25 decibels (ASA 1951 standard) on any one frequency on both ears. A portable audiometer (Beltone, Model 10-C) was used for the hearing tests.

An Ampex recorder (Model 602) utilizing a cardioid microphone (Ampex, Model 803) was used to record the three speaking situations. In order to randomize the speech samples for listener ratings, a second recorder (Ampex, Model 601) was used. During the listener ratings, samples were

presented using an amplifier-speaker (Ampex, Model 692) connected to the Ampex Model 602 recorder.

The children were tested in a small hospital room. An effort was made by the examiner to reduce as much ambient noise as possible as the room was not sound treated. Only the tester and one subject at a time occupied the test room. Each subject was seated in a chair in front of the microphone. The subject was told to speak into the microphone from a distance of approximately 10 inches. An effort was made by the tester to keep the subject's voice from "over" or "under" peaking on the V.U. meter on the Ampex recorder by controlling the microphone recording level. Four readings of the ambient noise present within the test room were made using a sound pressure level meter (Bruel and Kjaer, Model 2203). Two readings were made during the presence of noise produced by a thermostatically controlled air conditioning unit and two when the noise produced by this unit was not present. The intermittent ambient noise ranged in decibels from 35 to 65 (re .0002 dyne/cm.^{2}).

III. PROCEDURE

The procedure for this study can be discussed in three parts: (1) the stimuli used for obtaining recorded responses, (2) methods for obtaining the recorded samples of speech, and (3) methods for obtaining the listener ratings of the recorded responses.

Stimuli Used for Obtaining Recorded Responses

Structured single words. The following words were selected and used for obtaining single word responses from the subjects in this study: "peas," "to," "cool," "thief," "soup," and "shoes." These words were selected as their phonemic construction hypothetically would give the subjects the greatest degree of difficulty in terms of articulation as well as in keeping nonnasal sounds from becoming nasalized. (See Chapter II.) The words were structured to contain voiceless plosives and fricatives in the initial position followed by the vowel sounds (i) and (u).

Structured phrases. All of the single words listed above were included within the structured phrases. The structured phrases were three words in length and, with the

exception of one phrase, both the first and last word within the phrase contained the control plosive or fricative phonemic unit. The six structured phrases were as follows: "pick the peas," "to the top," "keep it cool," "catch the thief," "sip the soup," and "polish the shoes."

Unstructured running speech. Each child was asked to tell a story ("The Three Bears") in order to obtain recorded samples of the subject's connected speech. Three 10 second segments were selected from each subject's connected speech. The criterion for selection of the three segments was that it contain no pause longer than three seconds within that sample. The 10 second samples were taken toward the middle of the story.

Methods of Obtaining the Recorded Samples of Speech

In order to reduce the possibility of a child's beginning the task without understanding the directions, a brief "warm up" or "trial" session was held before obtaining the samples to be used for analysis. According to information reported by McCarthy (1954), such a "trial" session would probably lead to less "shyness" and longer responses. McCarthy reported that the first ten responses were, on the

average, shorter than the succeeding groups of ten responses, indicating "an overcoming of shyness during the observation."

Thirteen 4 x 6 inch index cards with the printed stimuli were used to elicit the responses from the subjects. Six of the cards had one word of the set of structured single words printed on them; six of the cards contained one of the structured phrases; and the remaining card had the words "The Three Bears" printed on it. These cards were randomized before presenting them to each subject. Each subject was instructed in the following manner, "I want you to say these words after me." The tester said the test word or phrase once for the subject and then the subject said the test word or phrase into the microphone. When the index card with "The Three Bears" printed on it was presented to the subject, the tester gave the subject the following instructions: "We are now going to play a little game. I will tell you the story of 'The Three Bears,' and then I want you to tell it to me." The tape recorded samples of unstructured running speech were obtained from the recording of each subject's rendition of "The Three Bears."

Methods of Obtaining the Listener Ratings of the Recorded Responses

Preparation of tapes for rating sessions. The samples of the structured words, structured phrases, and unstructured running speech were randomized on a master reel by "dubbing" the samples from an Ampex 602 to an Ampex Model 601 recorder. Each subject's set of structured words, structured phrases, and each of the three 10 second samples of unstructured running speech was numbered consecutively from 1 to 225 (the grand total of all speech samples recorded for all subjects). Numbers were drawn randomly utilizing a Horton-Smith table of random numbers, and the speech sample assigned to the number drawn was then re-recorded on a master reel. The master reel of 225 speech samples in random order was then played backwards to the auditors. It was anticipated that randomization of the speech samples would reduce the possibility of ratings on the first few samples heard affecting the later samples to be judged. All of the backward samples of speech were numbered on the master reel to reduce the possibility of listener counting errors.

Training session. A training session to eliminate listener unfamiliarity with the speech samples to be rated, and with the procedure for rating the types of speech samples to be heard took place prior to the final ratings. The instructions and types of speech samples heard during the training session were identical with those during the final ratings of nasality. Ten samples representing all three types of speech samples (words, phrases, and running speech) were played to the raters, and they were instructed to mark their rating on a trial form. Upon completion of the ratings of the ten samples, the experimenter checked to see if the raters understood the directions. Questions from the raters concerning the procedure were answered at this time.

Ratings of nasality. The procedure for obtaining nasality recordings was reached by taking into consideration the information reported by Sherman (1954) that backward playing of recorded speech reduces the possibility of irrelevant factors such as articulation errors influencing the nasality judgments of the listeners, and the finding reported by Prins and Bloomer (1966) that stability of nasality ratings are greater from a group of listeners than from

individual listeners. A group of seven listeners (five graduate students in speech pathology and two clinical staff members) were asked to judge independently the nasality of these speech samples utilizing the method of absolute judgment. The judges were given the following instructions:

1. "You are going to hear some speech samples played backwards."
2. "Please rate the samples in terms of nasal voice quality by using the rating sheet in front of you."
3. "A rating of one (1) will be used to designate no nasality present, and the number seven (7) will be used to designate extreme nasality present in the speech sample."
4. "Please circle the number along the continuum which you think best represents the voice quality in terms of nasality of that specific speech sample."
5. "You will have approximately seven seconds for scoring between each sample which should be sufficient time for recording the number."

6. "Please rate all the speech samples heard."

7. "Please work independently."

The numbers one through seven were chosen on the basis of information reported by Symonds (1924) who concluded from a study of the loss of reliability in ratings due to coarseness of the scale that seven steps is the optimal number.

One hour was required for the rating sessions.

CHAPTER IV

RESULTS AND DISCUSSION

The data compiled were analyzed to test the hypothesis that ratings of nasality on the words, phrases, and running speech are the same. The null hypothesis was stated as follows: In terms of nasality ratings, there is no significant difference among ratings of structured single words, structured three-word phrases, and unstructured running speech samples. In testing the hypotheses a significance level of .01 was chosen.

Each of the 15 subjects was rated on the three types of speech samples (six words, six phrases, three segments of running speech) by each of the seven judges. Mean nasality ratings were computed by totaling the ratings for each of the three types of samples for each subject and dividing by the number of ratings. For example, in obtaining the mean rating for the single words spoken by subject number one, six ratings were made by each judge, making a total of 42 ratings. By examination of Table I, it can be observed that the mean ratings for words ranged from 2.98 to 5.17 with an

TABLE I

MEAN NASALITY RATINGS BY SEVEN RATERS ON SIX WORDS, SIX PHRASES AND THREE RUNNING SPEECH SAMPLES

Subject No.	Words	Phrases	Running Speech
1	3.66	3.50	3.05
2	3.60	4.17	5.52
3	3.05	3.50	3.71
4	3.21	3.48	4.95
5	2.98	2.55	2.71
6	3.57	4.05	4.95
7	5.17	5.48	6.89
8	3.43	3.83	5.05
9	3.26	3.79	5.10
10	3.88	4.31	4.20
11	3.33	3.36	3.00
12	3.36	3.69	4.24
13	3.19	3.55	3.62
14	4.79	5.79	6.00
15	3.69	4.24	5.30
Mean	3.60	3.95	4.55
Standard Deviation	2.28	3.03	4.43

overall mean of 3.60. The mean ratings on the phrases ranged from 2.55 to 5.79 with an overall mean of 3.95. The mean ratings for the running speech samples ranged from 2.71 to 6.86 with an overall mean of 4.55. The overall mean for each of the three types of speech samples was obtained by totaling the mean ratings for each subject on each type of speech sample and dividing by the number of subjects.

I. RELIABILITY OF RATINGS

To determine the reliability of ratings, a statistic known as intraclass correlation was used. This method, suggested by Ebel (1951) for estimating reliability of ratings, gave an average intercorrelation of ratings of the 15 subjects from all possible pairs of seven raters. Ebel's formula is

$$\bar{r}_{11} = \frac{Vp - Ve}{Vp + (k - 1)Ve}$$

where $\bar{r}_{11}$ is equal to the reliability of ratings for a single rater, Vp is equal to variance for persons, Ve is equal to variance for error, and k is equal to the number of raters. The above formula gives the mean reliability for one rater. The reliability of the mean of k ratings for

each person would be greater. For the reliability for mean ratings from k raters, Ebel suggests the formula

$$r_{kk} = \frac{Vp - Ve}{Vp} .$$

Following the procedure put forth by Ebel, Vp (variance for subjects) was calculated to be 4.20, and Ve (variance for error) was calculated to be 0.43. (See Table II.) Using the variances in the formula for reliability of ratings for a single rater, $\bar{r}_{11}$ was found to be .56. In determining the reliability for mean ratings from the seven judges, r_{77} was found to be .90 using the above variances.

In these computations, the ratings given each subject by each judge on all speech samples were summed and divided by the total number of speech samples. Table III indicates the mean nasality ratings for each subject as given by each of the seven raters on all of the speech samples spoken.

No computation of intrajudge reliability was made since Slawson (1922) found that two ratings by the same rater are no more valid than one. His study indicated "that a rater repeats the same constant errors a second time, and the means of his ratings therefore deviate just as far from the truth as do single judgments."

TABLE II

COMPUTATION OF THE VARIANCE NEEDED TO ESTIMATE RELIABILITY OF THE RATINGS

Source of Variance	Sum of Squares	Degrees of Freedom	Variance
From subjects	58.75	14	4.20
From raters	21.24	6	*
From remainder	35.84	84	.43
Total	115.83	104	

*Variance not needed and not computed.

TABLE III

SUMMARY OF MEAN RATINGS MADE BY SEVEN RATERS
DISREGARDING SPEECH SAMPLE TYPE

Subject	Judges							Sum
	1	2	3	4	5	6	7	
1	3.13	4.47	3.67	2.67	3.60	3.60	3.00	24.14
2	4.07	4.93	3.33	4.80	4.27	3.27	4.13	28.80
3	3.07	3.47	2.40	4.20	3.93	2.87	3.60	23.54
4	4.40	2.73	2.47	6.33	4.13	1.60	3.93	25.59
5	3.53	2.13	1.47	2.73	2.93	2.33	4.27	19.39
6	4.00	4.27	3.73	3.60	4.53	3.33	4.67	28.13
7	6.40	3.87	5.40	6.27	6.27	4.93	6.00	39.14
8	3.53	3.60	3.60	3.87	4.53	3.80	4.13	27.06
9	3.73	3.80	3.40	3.67	4.00	3.73	3.87	26.20
10	4.80	3.80	4.07	4.07	4.20	4.00	3.47	28.41
11	3.27	3.87	2.73	3.80	3.27	2.93	3.20	23.07
12	4.60	3.33	2.80	5.33	3.73	1.67	3.60	25.06
13	4.13	3.40	2.87	3.20	4.00	3.73	2.53	23.86
14	6.20	5.87	5.53	6.73	5.13	3.60	5.87	38.93
15	4.33	3.40	3.60	4.73	4.73	4.00	5.00	29.79
Sum	63.19	56.94	51.07	66.00	63.25	49.39	61.27	411.11

After calculating the mean nasality ratings for each subject for each type of speech sample, a two-way analysis of variance using a randomized block design was performed to test the null hypothesis. In this design each subject represented a block upon which the three types of speech samples were imposed.

II. RESULTS OF ANALYSIS OF VARIANCE

The analysis of variance yielded a calculated F score of 8.09 ($f.01 = 5.46$, $df = 2/28$) (see Table IV). As the calculated F(8.09) was greater than the critical F(5.46) at the .01 level of significance, the null hypothesis was rejected indicating a significant difference in the nasality ratings among the words, phrases, and running speech samples.

III. COMPARISON OF THE MEAN NASALITY RATINGS ON THE THREE TYPES OF SPEECH SAMPLES

As a significant difference was found in nasality ratings among the three speaking situations, *t* tests were employed to test the following hypotheses, stated in null form:

TABLE IV

SUMMARY OF ANALYSIS OF VARIANCE OF NASALITY RATINGS OF FIFTEEN SUBJECTS IN THREE TYPES OF SPEECH SAMPLES BY SEVEN RATERS

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F*
Between subjects	19.846	14		
Between speech samples	7.717	2	3.86	8.09
Residual error	13.365	28	.477	
	40.978	44		

*Significant at .01 level of significance.

1. There is no significant difference between the nasality ratings on words and phrases.
2. There is no significant difference between the nasality ratings on words and running speech samples.
3. There is no significant difference between the nasality ratings on phrases and running speech samples.

The mean difference between the ratings of words and phrases was found to be .343 with a standard deviation of differences of .327 (see Table V). The computed t of 4.07 (t.01 = 2.98, df = 14) indicated a significant difference between the ratings on words and phrases. The first null hypothesis, stated above, was therefore rejected.

To test the null hypothesis that there is no significant difference between the ratings on words and running speech samples, a second t test was computed. The mean difference between the ratings of words and running speech samples was found to be .941 with a standard deviation of differences of .861. As the computed t was found to be 4.24 (t.01 = 2.98, df = 14), the null hypothesis was rejected.

TABLE V

DIFFERENCES IN MEAN RATINGS OF NASALITY BETWEEN THREE SPEAKING CONDITIONS

Comparison	Mean Difference	Sample Standard Deviation	t*
Phrases-Words	.343	.084	4.07
Running Speech-Words	.941	.222	4.24
Running Speech-Phrases	.600	.173	3.41

*Any value of t greater than 2.98 significant at .01 level.

The null hypothesis which states that there is no significant difference between phrases and running speech samples in terms of nasality ratings was rejected. The mean difference between the ratings of phrases and running speech samples was found to be .600 with a standard deviation of differences of .682. The computed t for the two types of speech samples was found to be 3.41 ($t_{.01} = 2.98$, $df = 14$).

IV. THE RELATIONSHIPS AMONG THE THREE SPEECH SAMPLES AS DETERMINED BY CORRELATION COEFFICIENTS

After testing the aforementioned hypotheses, a decision was made by the experimenter to obtain correlation coefficients to determine the relationships among the three types of speech samples. In computing the correlation coefficients, the following formula was used:

$$r = \frac{n\Sigma XY - \Sigma X \Sigma Y}{\sqrt{\left[n\Sigma X^2 - (\Sigma X)^2\right]\left[n\Sigma Y^2 - (\Sigma Y)^2\right]}}$$

where

r = degree of relatedness between two variables,

n = total number of scores, and

X, Y = original pairs of scores.

The correlation coefficient between words and phrases, between words and running speech samples, and between phrases and running speech samples were .81, .72, and .84 ($r.01 = .641$, $df = 13$), respectively (see Table VI).

As the above correlations were found to be significant individually, the experimenter calculated the significance of difference between the three correlations using a statistic put forth by Ferguson (1959) in which a t score was obtained. The calculated t was found to be 3.055 indicating no significant difference among the three correlations.

V. DISCUSSION

The results of the study indicated that even though significant differences existed between each of the paired speech samples, the relationships between the paired speech samples were positively correlated. The strong relationships that existed between words and phrases (.81), between words and running speech samples (.72), and between phrases and running speech samples (.84) seem to reveal that nasality ratings on both words and phrases are similar in their ability to indicate the nasality on running speech. As the correlation between words and running speech samples was

TABLE VI

CORRELATION COEFFICIENTS (r) BETWEEN PAIRED SPEECH SAMPLES

Speech Sample Pairings	r*
Words and Phrases	.81
Words and Running Speech Samples	.72
Phrases and Running Speech Samples	.84

*Any value of r greater than .641 significant at the .01 level.

lower than the correlation between phrases and running speech, it appears that nasality ratings on phrases are somewhat better indicators of the nasality ratings on running speech samples.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY OF THE STUDY

The present study was undertaken to determine the relationships among nasality ratings of structured single words, structured three-word phrases, and unstructured running speech samples spoken by 15 cleft palate children. Judgments of nasal voice quality were obtained by having seven trained listeners rate the selected recorded speech samples of each subject. The mean scale values of nasality for each subject in the three conditions were compared.

Intraclass correlations were computed to determine the reliability of the judgments. The average reliability for any one judge was found to be .56. The average reliability for seven raters as a group was .90. These correlations would appear to indicate that the judgments made were sufficiently stable for testing the hypotheses in this study.

A two-way analysis of variance using a randomized block design was performed to determine if a statistically

significant difference existed in terms of nasality ratings among words, phrases, and running speech samples. The resulting F ratio of 8.09 was significant at the .01 level of significance.

In order to ascertain if a significant difference existed in terms of nasality ratings between all possible combinations of the speech samples, t tests derived from the mean ratings of the paired speech samples were utilized. The resulting t scores of 4.07 between words and phrases, 4.24 between running speech samples and words, and 3.41 between running speech samples and phrases were all significant at the .01 level.

Correlation coefficients were obtained to determine the existing relationships among the ratings of the three types of speech samples. The correlation coefficient between words and phrases was found to be .81. The computed correlation coefficients between words and running speech samples and between phrases and running speech samples were .72 and .84, respectively. No significant difference was found among the above three correlations.

II. CONCLUSIONS

The following conclusions may be drawn from analysis of the data obtained in the study:

1. In terms of judging nasality from backward playing speech samples reliable group ratings can be obtained from judges trained in speech pathology.
2. Nasality ratings on structured single words are more related to ratings of nasality on structured three-word phrases than to ratings of unstructured running speech.
3. Nasality ratings on structured three-word phrases are more related to ratings of nasality on unstructured running speech than are ratings on structured single words.
4. A high positive correlation exists among the nasality ratings for all types of speech samples observed in this study.

These findings should not be accepted or rejected without consideration of the following limitations:

1. The "control" phonemic consonants in the single words were in the initial position only.

2. The responses recorded for the ratings consisted only of six words, six phrases, and three running speech samples.
3. The subjects were given auditory and visual stimulation on words and phrases but just visual stimulation on the running speech.
4. The testing room was not sound treated.
5. A small population sample was used.

III. SUGGESTIONS FOR FURTHER STUDY

The following suggestions for future studies are offered by the examiner.

1. A study involving more responses on the three types of speech samples in which the "control" phonemic consonants are represented in all positions is suggested.
2. A study utilizing item analysis in which statements could be made as to which type of words and/or phrases are better predictors of nasality should be considered.
3. The ratings of nasality by judges trained in speech pathology as opposed to judges untrained

in speech pathology could be analyzed in a future study.

4. A study should be conducted to determine if there is a difference in the ability to detect nasality using a sound spectograph from speech played backwards or forwards.
5. A study could produce evidence as to whether a significant difference exists between "telling a story" and other types of running speech.
6. It is suggested that a future study analyze different types of rating scales in terms of rating nasality.
7. A study involving other phonemic units in terms of nasality ratings should be considered.

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