Misarticulations and Listener Judgments of the Speech of Individuals with Cleft Palates

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Many investigators have been concerned with the articulatory errors of speakers with cleft palates. Both articulation tests and scaling techniques have been employed to study these errors.

Articulation tests used by various investigators have included single-word responses to picture cards (*1, 2, 4, 7, 15, 16, 17, 24, 25, 26, 27, 31*), phonetically-balanced word lists (*7, 14, 29*), nonsense syllables (*10, 29, 30, 32*), and phrases and sentenecs (*6, 13, 14, 32*). The general findings of these investigations indicate that children with cleft palates, as a group, are retarded in articulatory skills and exhibit similar patterns of articulation errors.

The second method of studying the articulation errors of individuals with cleft palates has involved psychological scaling techniques. Judgments of articulation defectiveness have usually been made of short samples of conversational speech or oral reading. Various types of scaling procedures have been utilized to obtain such judgments. The most frequently used procedure has been that of equal appearing intervals (*2, 4, 11, 14, 15, 18, 21, 22, 23, 27*). Recently another method, direct magnitude estimation, has also been utilized (*3, 18*). It has been demonstrated that reliable judgments of articulation defectiveness can be obtained by either of these scaling techniques.

There have been few investigations of the factors which may influence judges' ratings of articulation defectiveness of cleft palate speech samples. Falck (*7*) found that ratings of nasality, intelligibility, and defectiveness are highly related. Other investigators (*4, 14, 23, 29, 32*) have also found relationships between nasality and intelligibility and/or articulation-defectiveness ratings. These findings suggest that either these speech characteristics are truly related or the interrelationships are artifacts of the scaling procedure; i.e., judges do not rate each characteristic independently but tend to use a criterion which involves all of these dimensions.

Jordan (*11*) and Prins (*19*) have studied the relationships between the frequency and types of articulation errors found in the speech of children

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This research was supported in part at the University of Iowa by Grant D-853 from the National Institute of Dental Research, Public Health Service.

with functional articulatory defects and scaled ratings of severity. However, little is known about these relationships as they pertain to the speech of children with cleft palates. On the basis of the findings of previous research one might reason that errors on certain types of sounds (for example, fricatives) and some types of misarticulations (for example, glottal-stops) have a different influence on severity judgments of the speech of individuals than do other types of errors.

The present study was designed to answer the following questions: a) Can an over-all rating of severity of articulation defectiveness of children with cleft palates be predicted by multiple-correlation techniques from measures obtained from an articulation analysis of a standard sample of speech? b) What is the relative contribution of selected variables in predicting a rating of severity of articulation defectiveness in the speech of children with cleft palates?

Procedure

SUBJECTS. Subjects in this study were 154 children between five and 14 years of age with a congenital cleft of the palate or cleft of the lip and palate. No subject was utilized who had experienced adolescent voice change or who exhibited a hearing loss.[1] No restrictions were made on the basis of the type of physical management, if any, utilized to close the palatal cleft.

SPEECH SAMPLE. The following standard test sentences were used in eliciting a sample of speech from each subject. Consonant sounds scored on the articulation analysis are phonetically transcribed below each sentence.

1. Most boys like to play football.
   m st b z l k t pl f tb
2. Do you have a brother or sister?
   d j h v br ð s st
3. Ted had a dog with white feet.
   t d h d d g w θ hw t f t
4. We shouldn't play in the street.
   w ʃ dn t pl n ð str t
5. Playing in the snow is fun.
   pl ŋ n ð sn z f n
6. Nick's grandmother lives in the city.
   n k s gr ndm ð l v z n ð s t
7. We go swimming on a very hot day.
   w g sw m ŋ n v h t d
8. I like ice cream.
   l k s kr m

[1] In this study hearing loss was defined as any pure tone loss averaging greater than 20 decibels in the better ear for the speech frequencies (500, 1000, and 2000 cycles per second).

9. Tom has ham and eggs for breakfast.
   t m h z h m nd gz f br kf st
10. We went to town yesterday.
   w w nt t t n j st d
11. Can you count to nine?
   k n j k nt t n n
12. Do you want to take my new cap?
   d j w nt t t k m n k p
13. Do you know the name of my doll?
   d j n ð n m vm d

The speech sample was constructed to meet the following criteria: a) The fraquency of occurrence of the various consonant sounds was approximately equal to their relative frequency of occurrence in the English language as determined from Jordan's (*11*) reclassification of the data of French, Carter and Koenig (*8*). At least 20 sounds were included in the sample from each of the following classifications: fricatives, stop-plosives, glides, nasal semi-vowels, and blends. As constructed, the sample contained a total of 149 consonant sounds:[2] 56 stop-plosives, 33 fricatives, 31 nasal semi-vowels, and 29 glides. There were 21 consonant blends in various combinations. b) Only words found in first grade readers were used. c) No words were utilized which tend to vary in pronunciation because of regional dialect.

Recording Procedure. Each subject was asked to repeat each standard sentence after the experimenter. In order to compare the experimental recording procedure with conversational speech, a sample of conversational speech, approximately 15 seconds in length, was elicited from 30 of the 154 subjects.

Articulation Scaling Procedures. The 154 tape-recorded samples of the test sentences were edited and within each speech sample the order of presentation of the 13 test sentences was randomized. The samples were then randomized and re-recorded onto another tape with an assigned number preceding each sample and a five-second interval separating adjacent samples. Because the method of direct magnitude-estimation was used for the scaling of articulation defectiveness, a standard sample was selected by the experimenter and two other experienced observers. This sample was chosen to be grossly representative of medium severity on a continuum of articulation defectiveness. The 30 samples of conversational speech were also edited and re-recorded in the same manner.

A group of 22 observers judged the severity of articulation defectiveness of the 154 samples. All judges were students or staff members of the

[2] Considered as vowels and not included in this study were /ɝ/ as in *birds* (stressed syllabic), /ɑ/ as in *car* (post-vocalic), or as in hammer (unstressed syllabic), /1/ as in *bell* (post-vocalic) or as in *table* (unstressed syllabic), and /m/ as in *chasm* (unstressed syllabic).

Department of Speech Pathology and Audiology, University of Iowa. The judges were asked to rate the articulation defectiveness of each sample. Since the experimental samples contained the same sentences but in different order, each judge was furnished with a copy of the standard test sentences, as suggested by Cooker (*3*), to minimize adaptation and practice effects. The judges rated 10 practice samples before judging the experimental samples. The standard stimulus was assigned a value of '100' and presented after every tenth sample. The same group of judges also rated the 30 samples of conversational speech by the method of direct magnitude estimation.

Reliability of Scaling. The inter-judge reliability of the mean scale values over N judges ($N = 22$) was determined by the intra-class correlation techniques adjusted for trend (*5*). The reliability coefficient for averaged ratings of articulation was .95. To determine whether the repeated-sentence samples were representative of conversational-speech samples, mean scale values obtained on the two types of samples were compared. The obtained correlation coefficient, computed between the two sets of values for 30 subjects, was .95.

Articulation Analysis. An analysis of the recording of each subject's speech was made by the experimenter. The experimenter scored each of the 149 consonants of the speech sample according to the following categories: a) Correct consonant production: A sound was considered correct if it was produced in a manner which was not audibly defective to the experimenter. b) Sound omission: No audible characteristic of the correct sound or any other sound was present. c) Sound substitution: The substituted sound was another correctly-produced English phoneme. (Glottal-stop substitutions were considered in another category.) d) Distorted sound substitution-nasal: The substituted sound was a recognizable but atypical production of another English phoneme characterized by perceived nasal emission. e) Glottal-stop substitution: An audible obstruction of air flow, assumed to be at the level of the glottis, was substituted for the desired sound. f) Sound distortion: The produced sound was a recognizable but atypical production of the sound, not accompanied by perceived nasal emission. (None were classified as unrecognizable.) g) Sound distortion-nasal: The produced sound was a recognizable but atypical production of the desired sound, accompanied by nasal emission.

The measures which were derived from the articulation analysis of the recorded speech samples are listed in Table 1.

Reliability of Articulation Analysis. The inter-judge reliability of the articulatory measures was determined by having a second trained judge make an analysis of 10 selected samples. To determine the intra-judge reliability, the investigator made an analysis of 10 selected samples on two separate occasions. The number of agreements and disagreements were determined for both the intra- and inter-judge situations; agreement of the

TABLE 1. Proportion of agreement in categorizing articulation errors during two listening sessions: experimenter versus experimenter (E-E) and experimenter versus another trained judge (E-J).

Type of Error	*Proportion of Agreement*	
	E-E	*E-J*
Total Errors	.86	.75
Fricatives Misarticulated	.89	.80
Stop-Plosives Misarticulated	.84	.72
Glides Misarticulated	.67	.67
Nasal Semi-Vowels Misarticulated	.85	.67
Glottal-Stop Substitutions	1.00	.50
Omissions	.89	.84
Distortions-Nasal	.88	.63
Distortions	.89	.76
Substitutions-Nasal	.85	.67
Substitutions	.92	.80
Errors on Arresting Consonants	.88	.82
Errors on Releasing Consonants	.84	.81

experimenter with himself and with the other judge was computed for each of the 13 measures by the following formula:

$$\text{proportion agreement} = \frac{N_A}{N_A - 1/2\ N_D}$$

where N_A = number of agreements and N_D = number of disagreements. The term $\frac{1}{2}N_D$ in the above formula was utilized on the assumption that one-half of the sounds on which disagreement occurred were considered by chance to be in error.

The results of the reliability analysis are presented in Table 1. Some variation in proportion of agreement as a function of the measures can be noted; however, the reliability of most measures appeared to be adequate.

NASALITY SCALING PROCEDURES. A group of 19 observers judged the severity of nasal voice quality of the 154 samples (13 standard test sentences for each subject). The method of backward play was utilized in presenting these samples since this method appears to decrease the influence of other factors on voice quality judgments (*20, 23*). The procedure for obtaining the nasality judgments and the determination of judgment reliability was the same as for the scaling of articulation defectiveness. The reliability coefficient for ratings of severity of nasal voice quality, averaged over 19 judges, was .85.

Results

The data obtained in this study were analyzed by successive multiple correlation procedures (*12, 33*). The dependent variable in each analysis was judged severity of articulation defectiveness. A total of 14 independent variables included 13 measures obtained from the articulatory analysis of the standard speech sample and the measure of judged severity of nasal voice quality. A Model 7070 IBM electronic computer was used for all computations.

The particular independent variables to be included in each analysis were chosen partly on logical bases but primarily on the basis of an examination of the intercorrelations between variables. In order to utilize variables which were relatively independent, an attempt was made to identify 'clusters' of related variables. Variables most representative of a cluster were then submitted to further analysis.

ANALYSIS NUMBER 1. In the first multiple regression analysis all 14 independent variables were included. A multiple correlation coefficient (R) of .935 was obtained. The beta weights of each independent variable are presented in Table 2. The analysis also yielded the correlations of the dependent variable with each independent variable and the intercorrelations of the independent variables (Table 3).

It can be noted from Table 2 that a number of the variables had beta weights which were statistically significant. The largest was that of variable 13: errors on releasing consonants.

ANALYSIS NUMBER 2. An examination of the intercorrelation matrix in Table 2 indicated that variable 2 (total errors), variable 13 (errors on releasing consonants), and variable 14 (errors on arresting consonants) were closely related to each other and generally related to all of the other

TABLE 2. Beta weights of the various independent variables and multiple correlation coefficients derived from four analyses. Those beta weights which are significant at the .05 level are asterisked.

Independent Variable	*Analysis 1*	*Analysis 2*	*Analysis 3*	*Analysis 4*
1. Nasality	.062*	.046		
2. Total Errors	.197			
3. Fricatives Misarticulated	.117	.153		
4. Stop-Plosives Misarticulated	.046	.284	.623*	.626*
5. Glides Misarticulated	.002	.116*	.356*	.356*
6. Nasal Semi-Vowels Misarticulated	.072	.082*		
7. Glottal-Stop Substitutions	−.114	.054		
8. Omissions	−.426	.342*		
9. Distortions-Nasal	−1.031*	−.052		
10. Distortions	−.418*	−.002	.028	
11. Substitutions	−.312*	.032		
12. Substitutions-Nasal	−.003	.085*		
13. Errors on Releasing Consonants	1.339*			
14. Errors on Arresting Consonants	.454			
Multiple Correlation Coefficient (R)	.935	.929	.883	.883

independent variables. These relationships are not surprising since the three variables include portions of all the other variables; e.g., total errors is the sum of variables 13 and 14, of variables 3 through 6, and variables 7 through 12. As a result of these part-whole relationships these three variables, and primarily variable 13, carry almost the entire weight in the first multiple regression equation. In the second analysis, therefore, variables 2, 13, and 14 were deleted on the basis of their intercorrelations with the remaining variables.

The results of the second analysis are also presented in Table 2. A multiple correlation coefficient (R) of .929 was obtained. The second analysis demonstrates that there was little decrease in the multiple correlation coefficient when variables 2, 13, and 14 were deleted.

Analysis Number 3. Examination of the remaining variables indicated that there were further obvious relationships among measures. Several variable groupings were apparent upon examination of each specific variable and its relationships with other variables. Groupings or clusters were formed first with variables which exhibited intercorrelations of .50 or greater. Using this criterion two different clusters were identified. Cluster I consisted of variables 3, 4, and 9 (fricative misarticulations, stop-plosive misarticulations and distortions-nasal). Cluster II consisted of variables 5, 6, and 11 (glide misarticulations, nasal semi-vowel misarticulations, and substitutions).

Examination of the remaining variables revealed that variable 1 (nasality) and variable 12 (substitutions-nasal) were more closely related to variables in Cluster I than to any other variables. Therefore, these two variables were included in Cluster I.

Two of the remaining variables, glottal-stop substitutions (variable 7) and distortions (variable 10) showed little relationship to any of the other independent variables. Since the occurrence of glottal-stop substitutions in the sample studied was small this variable was deleted from further analysis. Distortions, however, occurred frequently in the sample. Therefore, distortions were included in the third analysis as representative of a third category.

Variable 8 (omissions) was not included in the third analysis. This measure was related to some of the variables in both Cluster I and II but was not consistently related to all of the variables in either group.

Variables were chosen for the third analysis by considering the average correlation of each variable with other variables in the cluster and the absolute size of the beta weight found for each variable in analysis number 2. The measure of stop-plosive misarticulations was selected to represent Cluster I as it had both the highest average correlation and the greatest beta weight of the variables in that group. The measure of glide misarticulations was selected to represent Cluster II since it also had the highest average correlation and the greatest beta weight of any variable in that group. Distortions (variable 10) was the third variable included in the analysis. The multiple correlation coefficient (R) obtained with these three variables was .883. Table 2 shows the distribution of beta weights for the three variables.

ANALYSIS NUMBER 4. Examination of the variables in the third analysis indicated that variable 10 (distortions) had a small beta weight which was not statistically significant. This variable was therefore deleted. The two remaining variables, stop-plosive misarticulations and glide misarticulations, were then the only variables used in the fourth analysis. The multiple correlation coefficient (R) obtained was .883. The data in Table 2 indicate that the two beta weights, .626 for stop-plosive misarticulations and .356 for glide misarticulations, are essentially the same as in the third analysis. The lack of change in both the multiple R and the beta weights for stop-plosive misarticulations and glide misarticulations further substantiates the minor contribution of variable 10 (distortions) to the multiple regression.

Discussion

PREDICTION OF SEVERITY OF ARTICULATION DEFECTIVENESS. The results of this study indicate that severity of articulation defectiveness can be predicted with a fair degree of accuracy by several measures. When 11 independent variables were used to predict severity a multiple correlation coefficient (R) of .929 was obtained. These 11 variables accounted for 86% (R^2) of the variability of the dependent variable. This finding indicates that most of the important variables related to articulation defectiveness judgments were included in this study. When only variables 4 and 5 (stop-plosive misarticulations and glide misarticulations) were included in the analysis it was found that they accounted for 78% of the variability in articulation defectiveness. This represents a decrease in R^2 of only 8% from the value obtained in the analysis using 11 variables.

Articulation defectiveness can also be predicted fairly accurately by any of several single measures. It can be seen in Table 3 that three measures (errors or releasing consonants, total errors, and omissions) exhibit correlations of .85 or better with the dependent variable. Two other measures (stop-plosive misarticulations and errors on arresting consonants) exhibit correlations of .83 and .82, respectively, with the dependent variable.

RELATIVE CONTRIBUTION OF VARIABLES IN PREDICTING ARTICULATION DEFECTIVENESS. The relative weights of independent variables in the regression equation depend upon which variables are included in a particular analysis (see Table 2). Such differences in weighting are due partly to the fact that the independent variables are not completely independent. It is therefore advisable to attempt to derive independent measures either by examining intercorrelations, as was done in this study, or by some other method, such as factor analysis.

In the last analysis presented in Table 2, one variable (stop-plosive

TABLE 3. Intercorrelations between the variables studied.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Nasality	.51	.50	.51	.30	.20	.05	.29	.47	.09	.23	.28	.49	.52	.42
2. Total Errors		.91	.95	.70	.57	.39	.78	.63	.18	.55	.51	.98	.94	.88
3. Fricatives Misarticulated			.84	.57	.46	.36	.66	.63	.22	.48	.49	.88	.93	.79
4. Stop-Plosives Misarticulated				.58	.46	.43	.73	.69	.11	.44	.51	.96	.91	.83
5. Glides Misarticulated					.59	.15	.71	.27	.06	.64	.39	.74	.59	.72
6. Nasal Semi-Vowels Misarticulated						.10	.68	.07	.18	.58	.16	.55	.56	.63
7. Glottal-Stop Substitutions							.29	.19	.01	.16	.12	.41	.35	.36
8. Omissions								.18	.09	.58	.34	.79	.74	.86
9. Distortions-Nasal									−.29	−.05	.48	.65	.60	.41
10. Distortions										.19	−.25	.10	.26	.12
11. Substitutions											.32	.54	.52	.60
12. Substitutions-Nasal												.53	.48	.49
13. Errors on Releasing Consonants													.89	.89
14. Errors on Arresting Consonants														.82
15. Articulation Severity (Dependent Variable)														

misarticulations) contributed the major weight in the prediction of the dependent variable. The obtained differences in the magnitude of the weightings may be due to the fact that the occurrence of a particular type of error, for example, stop-plosive misarticulations, may be evaluated differently by the listeners than the occurrence of another type of error, for example, distortions. Or it may be that the frequency of occurrence of a particular type of error, for example, stop-plosives, may be greater in the sample studied and thereby have more effect upon the listeners' rating of severity. From the results of this study it is impossible to determine which of these two factors is the more influential in determining the relative weights of the variables.

Cluster I. Cluster I consisted of the following variables: stop-plosive misarticulations, fricative misarticulations, distortions-nasal, substitutions-nasal, and nasality. The relationship of the variables in this cluster indicates that they represent measures of the same factor to some degree. It may be noted that the correlation between variable 12 (distortions-nasal) and variable 1 (nasality) is lower than the intercorrelation of other variables in this cluster. This low relationship can perhaps be explained by the fact that errors on variable 12 occurred infrequently in the sample (mean number of errors = .56).

It appears that the factor represented by Cluster I might be labeled as a 'velopharyngeal closure' factor. It cannot be concluded from this study that the five variables in this cluster are in fact related to velopharyngeal closure; however, the findings of various investigators (*9*, *17*, *25*, *26*, *29*, *30*) have indicated that individuals with inadequate velopharyngeal closure usually have the most difficulty with those sounds requiring greater intraoral breath pressure, namely fricatives and stop-plosives. On a logical basis it would seem that the occurrence of distortions-nasal and substitutions-nasal, and the degree of nasal voice quality would also be related to the adequacy of velopharyngeal closure.

Cluster II. Cluster II consisted of the following variables: glide misarticulations, nasal semi-vowel misarticulations, and substitutions. The relationship of these variables also indicates that they represent measures of the same factor to some degree. It is a commonly accepted notion that substitutions occur when a child is learning to produce new sounds and that such substitutions often occur when a child is beginning to use a sound in place of a previous omission. It has also been demonstrated that glide consonants such as /l/ and /r/ are often in error in the speech of young children. It would appear, therefore, that Cluster II might be considered to represent a maturational or learning factor.

Results of previous research give little indication that misarticulations of glides or nasal semi-vowels are importantly related to articulation defectiveness of cleft palate speakers; however, the relative weightings of glide errors, when this variable is used to represent Cluster II, indicates that such errors have at least some influence on severity of articulation judgments.

Distortions. Distortions were not included in either of the clusters identified since this variable showed little relationship with any other independent variable. It was also the only measure which was not significantly related to the dependent variable. A tenable explanation of this finding may be that most of the misarticulations of children who have velopharyngeal closure problems will be omissions and substitutions. Distortion errors which occur in such cases would most likely fall in the category of distortions-nasal. Support for this conclusion can be found in Table 3. It can be seen that distortions show a small, but statistically significant, negative correlation with distortions-nasal and substitutions-nasal.

If a child has velopharyngeal incompetence, distortions would seem less likely to occur than most other types of errors. Conversely, if closure is attained, a child may be likely to distort some sounds, for examples, /s/ or /z/, and yet be considered very mild on the continuum of articulation defectiveness for children with cleft palates. Thus the occurrence of distortions in samples where other types of errors are prevalent may have little effect on judges' ratings of severity.

Omissions. Examination of Table 3 indicates that omissions are related to some variables in both Clusters I and II. The relationship to Cluster I may be due to the fact that children with cleft palates may omit pressure sounds when they do not achieve intraoral breath pressure. The relationship to Cluster II may result because children who are retarded in articulation skills may omit sounds.

Examination of the interrelationships between variable 8 (omissions) and variables in Cluster I suggests that omissions are related to pressure sounds (fricatives and stop-plosive misarticulations). These relationships can probably be explained by the fact that if an individual cannot produce stop-plosive and fricative sounds due to inadequate velopharyngeal closure, one type of error which may occur in such instances is that of an omission. This does not imply, however, that the occurrence of omissions is necessarily determined by the adequacy of velopharyngeal closure. The possible multiple causation of omissions can be contrasted to that of distortions-nasal and substitutions-nasal. The occurrence of these latter types of errors is probably determined almost entirely by the adequacy of velopharyngeal closure.

The relationships of variable 8 (omissions) to Cluster II variables can also be noted by examination of the intercorrelation matrix. It would seem plausible that omission errors are likely to be related to maturation for several reasons. First, omissions are likely to occur on glide consonants, such as /l/ and /r/, which are late in the pattern of sound acquisition. Second, omissions would be expected to be related to substitutions since both of these types of errors occur during the process of speech-sound acquisition.

Glottal-stop substitutions. Variable 7 (glottal-stop substitutions) was deleted in the third analysis because the frequency of occurrence of this variable was small (mean number of errors = .84). Such a frequency of occurrence is not in agreement with the findings of Spriestersbach, Moll, and Morris (*25*) who reported that more than 40% of the errors on stop-plosives as singles were glottal-stop substitutions. It is possible that different criteria for determining the occurrence of such errors were used in the two studies. It is also possible that the incidence of glottal-stop substitutions is less in connected speech samples such as those used in this tudy. Differences in methods of scoring may also be a factor in the discrepancy between the results of the two studies.

In the fourth and last analysis, the beta weights of .626 and .356 were obtained for stop-plosive misarticulations, representing Cluster I, and glide misarticulations, representing Cluster II. According to McNemar (*12*, p. 177) the square of the beta weight gives an indication of the relative contribution of the variable in accounting for the variance of the dependent variable. Therefore, it appears that the factor which may represent the adequacy of velopharyngeal closure makes approximately three times as much contribution as the factor which may represent maturation. These results agree with the research findings (*4, 9, 25, 26, 27, 30*) that the predominant factor accounting for variations in articulation defectiveness in the cleft palate population is the adequacy of velopharyngeal closure. A coefficient of determination (R^2) of .78 was obtained when two variables (stop-plosive misarticulations and glide misarticulation) were used to predict severity. Using these two variables a multiple R of .883 was obtained. A somewhat higher multiple R (.929) was obtained when nine additional variables were included in the analysis. Adding the other nine variables thus increases the coefficient of determination to .86. The increase of the multiple R can be accounted for in part by the fact that the variable chosen to represent any cluster is not perfectly related to other variables in the cluster. If a composite measure had been derived from each cluster, as would be the case if a factor analysis were used, it would be expected that these two factors would result in a higher multiple R than was obtained. However, the derivation of new measures to represent more adequately each cluster in the present study could result in a maximum increase in the multiple correlation of only .05.

The variability in severity of articulation judgments not accounted for by the variables used in this study (14%) may be due to unreliability of the measures used. It may also be due to variables not investigated, such as the vocal attributes of pitch, loudness, stress, and quality deviations other than nasality. Finally, it should be noted that the results of this study may be dependent upon the sample utilized.

Summary

The purpose of this study was to investigate the precision with which an over-all rating of severity of articulation defectiveness of children with cleft palates can be predicted by multiple correlation techniques from measures obtained from an articulation analysis of a standard sample of speech. The relative contribution of selected variables in predicting a rating of severity was also investigated.

Subjects were 154 children with a congenital cleft of the palate. Tape recordings were obtained for each subject's repetition of 13 standard test sentences. These speech samples were judged by 22 observers for severity of articulation defectiveness by the method of direct magnitude estimation. An articulation analysis was made of each subject's speech. From this analysis 13 different articulatory measures, representing the occurrence of errors on various classifications of speech sounds and various error types, were derived. A fourteenth measure, judged severity of nasal voice quality on samples played backwards, was obtained by the method of direct magnitude estimation.

The obtained data were analyzed by successive multiple correlation procedures. The dependent variable in each analysis was judged severity of articulation defectiveness. Independent variables included the 13 measures obtained from the articulatory analysis and the measure of judged severity of nasal voice quality. On the basis of the results of the regression analyses the following conclusions appear warranted: a) Severity of articulation defectiveness of children with cleft palates can be predicted with a high degree of accuracy by a combination of the independent vari-

ables utilized or by any of several single measures. b) Severity of articulation defectiveness appears to be related primarily to two factors, one representing the adequacy of velopharyngeal closure and one representing maturation. Velopharyngeal closure appears to be the predominant factor accounting for variation in judged articulation defectiveness.

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Acknowledgements: The author wishes to extend his appreciation to the staff members of the University of Iowa Hospitals, Indiana University and Medical Center, University of Oklahoma Medical Center, University of Kansas Medical Center, University of Illinois Research and Education Hospitals, and Northwestern Cleft Palate Institute, whose help made possible the collection of data for this study. Appreciation is expressed also to Dr. D. C. Spriestersbach and Dr. Kenneth L. Moll for their guidance and encouragement throughout the investigation.

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