A Factor Analysis of the Speech of Children with Cleft Palate

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The present study is a continuation of a previously reported investigation (*5*) in which the severity of misarticulations of children with cleft palate was studied by the use of multiple correlation technique. In that study, it was concluded that severity of articulation defectiveness can be predicted with a high degree of accuracy by any of several single measures or by a combination of measures. In general, however, severity of articulation defectiveness appeared to be related primarily to two measures, one representing the adequacy of velopharyngeal closure and one representing maturation. Of the two, velopharyngeal closure appeared to be the predominant factor accounting for variation in judged articulation defectiveness.

Multiple correlation technique is generally used as a statistical procedure for selecting those measures (called independent variables) which are most influential in predicting a general measure (the dependent variable). A general measure is composed of composite attributes; that is, articulation defectiveness may be influenced by various types of errors, manner of production categories, etc. Factor analysis, on the other hand, enables one to study those factors, general and/or specific, which make up the general measures. A measure may contribute to one or more factors. Factors are also loaded or weighted by different tests in varying degrees. Thus, by factor analysis techniques, one is able to examine the contribution of factors to the general measure and the influence of specific measures or tests in the make-up of a factor.

It is of research and clinical interest to determine whether the two previously reported factors (velopharyngeal closure and maturation) are evident when children with cleft palates are classified by manometer ratios. If such patterns or factors are demonstrated to contribute to articulation defectiveness, one must consider their relative contributions in various subclassifications of individuals with cleft palates.

The purpose of the present study was to evaluate the hypotheses: a) more than one factor contributes to the articulation defectiveness of

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children with cleft palates, and b) different patterns or factors exist when subclassifications of children with cleft palates are considered.

Procedure

Subjects were 154 children between five and 14 years of age with a congenital cleft of the palate. Tape recordings were obtained for each subject, and an articulation analysis of each subject's speech was performed. From this analysis 14 different articulation measures, representing the occurrence of errors on various classifications of speech sounds and the occurrence of various error types, were derived. Included in the articulation measures was judged severity of nasal voice quality determined by the method of backward play. Two additional measures were obtained for each subject: a) age, and b) oral breath pressure ratio[1]. The procedure used in analyzing the speech samples has been reported elsewhere (*5*).

Data from the 14 measures of the articulation analysis, manometer ratios, and age were submitted to the factor analysis program of an IBM 709 electronic computer[2]. Five different factor analyses were completed. They were the following:

I. A factor analysis of 14 different articulatory measures for the total group of subjects.

II. A factor analysis of 14 different articulatory measures, manometer ratios, and age for the total group of subjects.

III. A factor analysis of subjects with high breath-pressure ratios (manometer ratios of .90 or higher) on variables listed in Analysis II.

IV. A factor analysis of subjects with medium breath-pressure ratios (manometer ratios of .89 to .51) on variables listed in Analysis II.

V. A factor analysis of subjects with low breath-pressure ratios (manometer ratios of .50 or below) on variables listed in Analysis II.

Means, standard deviations, and correlation matrices were also computed for the above groups.

Results

Correlation coefficients of manometer ratios and age with other articulation measures are presented in Table 1. Subjects were first considered as a total group, and then by previously described subclassifications. Manometer ratios and age were significantly related to judge severity of articulation defectiveness ($r = .43$ and $.48$ respectively). As would be expected, manometer ratios and age generally show negative correlations with the articulation measures. When the total group is considered, *all* articulation measures are significantly related to *either* manometer ratios

[1] Oral breath pressure ratios were computed by dividing the manometer reading obtained with nostrils open by the reading obtained with nostrils occluded. A manometer allowing a small leak of air was utilized to minimize the occurrence of tongue-palate valving.

[2] The factor analysis program used was BIMD 17, developed by Biostatistics, U.C.L.A.

or age. Both manometer ratios and age are significantly correlated with several of the articulation measures for the low and medium breath-pressure groups; however, only age is significantly correlated with the articulation measures for the high breath-pressure group. Manometer ratios and age are independent measures except for the high breath-pressure group, where the correlation between the two measures was significant at the 5% level.

FACTOR ANALYSIS I. Fourteen variables were submitted to the factor analysis program of an electronic computer. Initial results indicated that 11 factors were present; however, five of the factors accounted for less than 5% of the total variance. Therefore, the 14 variables were resubmitted to the factor analysis program with six factors being rotated. Table 2 demonstrates that Factors 1 and 2 accounted for 74% of the total variance, while the remaining four factors were much smaller and were essentially specific factors. Factor 1 in this analysis accounted for 60% of the total variance and included major weightings on the following variables: fricatives, stop-plosives, nasality, and distortions-nasal. Major weightings were also evident for total errors, releasing errors, and arresting errors; however, since these variables are actually composite measures of all variables, they will be omitted in the discussion of the results of this paper. Factor 2 in this analysis accounted for 14% of the total variance and included major weightings on the following variables: glides, nasal semivowels, and omissions.

TABLE 1. Correlation coefficients of manometer ratios and age with other articulation variables for total group of subjects and subclassifications of low, medium, and high pressure ratio groups. Significance at the 5% level is indicated by an asterisk.

Variable	*Total* *N = 154*		*Low* *N = 19*		*Medium* *N = 56*		*High* *N = 79*	
	ratio	*age*	*ratio*	*age*	*ratio*	*age*	*ratio*	*age*
Nasality	−.30*	−.17*	−.30	.06	−.18	−.13	.07	−.24*
Total errors	−.54*	−.41*	−.26	−.18	−.33*	−.40*	.16	−.56*
Fricative errors	−.53*	−.37*	−.45	−.07	−.30*	−.39*	.06	−.47*
Stop-plosive errors	−.56*	−.33*	−.41	.07	−.38*	−.34*	.14	−.50*
Glide errors	−.23*	−.32*	−.05	−.14	−.09	−.24*	.21	−.43*
Nasal semivowel errors	−.10	−.43*	−.12	−.07	−.01	−.49*	.11	−.47*
Substitutions, glottal	−.32*	−.02	−.11	.20	−.36*	.05	.02	−.37*
Omissions	−.20*	−.45*	−.17	−.51*	−.06	−.37*	.21	−.51*
Distortions, nasal	−.61*	.02	−.36	.47*	−.19	.00	−.07	−.11
Distortions	.10	−.29*	.54*	−.28	−.27*	−.23	−.02	−.36*
Substitutions	−.20*	−.44*	−.15	−.34	−.24	−.46*	.21	−.50*
Substitutions, nasal	−.46*	−.16*	−.39	−.30	−.07	−.12	.10	−.21
Releasing errors	−.54*	−.36*	−.37	−.02	−.31*	−.36*	.15	−.53*
Arresting errors	−.49*	−.41*	−.42	.03	−.33*	−.45*	.09	−.51*
Manometer ratio		.02		−.17		.02		−.25*
Age	.02		−.17		.02		−.25*	

TABLE 2. Factor analysis I: variable weightings for 14 different articulatory measures for the total group of 154 subjects. Variables having a factorial weight of .50 or greater are indicated by an asterisk.

Variable	*Cumulative proportion of the total variance*					
	60% *Factor 1*	*74%* *Factor 2*	*83%* *Factor 3*	*89%* *Factor 4*	*93%* *Factor 5*	*96%* *Factor 6*
Nasality	.549*	.121	.069	.052	.083	.105
Total errors	.750*	.529*	.112	.231	.182	.196
Fricative errors	.768*	.390	.209	.222	.227	.159
Stop-plosive errors	.775*	.458	.063	.289	.195	.078
Glide errors	.337	.636*	.068	.005	.093	.424
Nasal semivowel errors	.185	.731*	.103	.015	.062	.286
Substitutions, glottal	.169	.099	.006	.936*	.018	.045
Omissions	.251	.900*	.043	.177	.176	.058
Distortions, nasal	.934*	.057	.330	.055	.074	.102
Distortions	.057	.069	.966*	.001	.132	.078
Substitutions	.109	.472	.147	.085	.186	.816*
Substitutions, nasal	.392	.118	.209	.024	.734*	.163
Releasing errors	.741*	.547*	.016	.256	.176	.198
Arresting errors	.738*	.483	.239	.189	.200	.137

Factor Analysis II. The results of the second analysis were essentially the same as the results of Analysis I (see Table 3). It will be noted that two additional variables were included, manometer ratios and age. Manometer ratios showed a substantial weighting on Factor 1, while age showed a sizeable weighting on Factor 2.

Factor Analysis III. The results of the third analysis (Table 4) indicated that for subjects with high breath-pressure ratios 70% of the total variance can be accounted for in one factor. None of the other five factors obtained in the analysis represented more than 9% of the total variance. The structure of Factor 1 consisted of major weightings on the following variables: glides, nasal semivowels, and substitutions-nasal. Neither manometer ratios nor age showed weightings greater than .50 on any of the factors in this analysis. This analysis also showed little similarity in factorial weightings and composition to Analyses I and II.

Factor Analysis IV. The results of the fourth factor analysis are presented in Table 5. For subjects with medium breath-pressure ratios, factors show a similarity in structure to those found in Analyses I and II. In the fourth analysis, Factor 1 accounted for 53% of the total variance. Variables with major weightings included nasality, fricatives, stop-plosives, and distortions-nasal. Factor 2 accounted for 13% of the total variance and consisted of major weightings on glides and substitutions. Factor 6 showed a similarity in composition to Factor 2 in Analysis I. Manometer ratios contributed to Factors 1 and 3, while age contributed to Factor 6.

Factor Analysis V. The results of the fifth factor analysis (Table 6)

TABLE 3. Factor analysis II: variable weightings for 14 different articulatory measures, manometer ratio, and age for the total group of 154 subjects. Variables having a factorial weight of .50 or greater are indicated by an asterisk.

Variable	*Cumulative proportion of the total variance*					
	59% *Factor 1*	*74%* *Factor 2*	*82%* *Factor 3*	*87%* *Factor 4*	*93%* *Factor 5*	*95%* *Factor 6*
Nasality	.533*	.171	.095	.075	.062	.060
Total errors	.739*	.584*	.129	.209	.114	.130
Fricative errors	.752*	.448	.238	.199	.067	.194
Stop-plosive errors	.773*	.499	.064	.263	.011	.146
Glide errors	.339	.692*	.092	.006	.379	.004
Nasal semivowel errors	.138	.765*	.088	.009	.173	.050
Substitutions, glottal	.199	.089	.002	.928*	.035	.003
Omissions	.241	.917*	.003	.195	.057	.128
Distortions, nasal	.952*	.049	.280	.012	.090	.020
Distortions	.005	.114	.956*	.005	.051	.149
Substitutions	.086	.591*	.169	.085	.714*	.226
Substitutions, nasal	.432	.150	.210	.005	.139	.690*
Releasing errors	.738*	.587*	.029	.233	.143	.107
Arresting errors	.722*	.546*	.251	.175	.027	.177
Manometer ratio	.634*	.008	.089	.233	.150	.215
Age	.080	.483	.293	.049	.077	.156

TABLE 4. Factor analysis III: variable weightings for 14 different articulatory measures, manometer ratio, and age for 79 subjects with high breath pressure ratios. Variables having a factorial weight of .50 or greater, are indicated by an asterisk.

Variable	*Cumulative proportion of the total variance*					
	70% *Factor 1*	*79%* *Factor 2*	*87%* *Factor 3*	*91%* *Factor 4*	*94%* *Factor 5*	*96%* *Factor 6*
Nasality	.115	.150	.451	.111	.056	.063
Total errors	.414	.332	.630*	.264	.171	.465
Fricative errors	.278	.283	.814*	.055	.058	.269
Stop-plosive errors	.278	.462	.506*	.297	.164	.526*
Glide errors	.638*	.092	.256	.259	.188	.354
Nasal semivowel errors	.717*	.037	.280	.187	.067	.380
Substitutions, glottal	.143	.600*	.292	.151	.362	.276
Omissions	.425	.096	.375	.323	.032	.744*
Distortions, nasal	.182	.931*	.171	.148	.092	.030
Distortions	.088	.035	.856*	.073	.463	.111
Substitutions	.428	.093	.594*	.536*	.074	.191
Substitutions, nasal	.663*	.240	.118	.107	.042	.016
Releasing errors	.488	.372	.521*	.265	.256	.454
Arresting errors	.272	.308	.756*	.153	.003	.469
Manometer ratio	.078	.042	.007	.419	.009	.059
Age	.196	.089	.327	.445	.181	.206

TABLE 5. Factor analysis IV: variable weightings for 14 different articulatory measures, manometer ratio, and age for 56 subjects with medium breath pressure ratios. Variables having a factorial weight of .50 or greater are indicated by an asterisk.

Variables	*Cumulative proportion of total variance*					
	53% *Factor 1*	*69%* *Factor 2*	*78%* *Factor 3*	*85%* *Factor 4*	*90%* *Factor 5*	*93%* *Factor 6*
Nasality	.530*	.112	.008	.002	.121	.058
Total errors	.663*	.236	.091	.321	.142	.608*
Fricative errors	.690*	.090	.084	.273	.158	.544*
Stop-plosive errors	.714*	.142	.119	.399	.107	.478
Glide errors	.134	.673*	.145	.262	.219	.506*
Nasal semivowel errors	.039	.306	.018	.107	.075	.876*
Substitutions, glottal	.204	.056	.027	.946*	.024	.065
Omissions	.135	.204	.124	.369	.054	.860*
Distortions, nasal	.918*	.181	.261	.052	.152	.058
Distortions	.107	.010	.960*	.002	.120	.117
Substitutions	.083	.856*	.161	.006	.005	.449
Substitutions, nasal	.375	.086	.151	.023	.901*	.054
Releasing errors	.616*	.290	.026	.381	.129	.577*
Arresting errors	.689*	.126	.192	.195	.153	.611*
Manometer ratio	.340	.200	.357	.282	.030	.099
Age	.147	.148	.235	.184	.049	.515*

indicate that for subjects with low breath-pressure ratios 46% of the total variance can be attributed to one factor. Sixteen per cent of the total variance can be attributed to a second factor.

The composition of the factors in this analysis does not closely resemble any of the other factorial structures. Major variable weightings contributing to Factor 1 were fricatives, plosives, glides, omissions, and distortions-nasal. Factor 2 consists of major weightings on omissions, distortions-nasal, and age. Manometer ratios contribute a major weighting to Factor 3.

Table 7 indicates the structural composition of major weightings (.50 or greater) for each factor in the five different analyses. It can be observed that the factors in Analyses I and II are essentially the same in composition and in order. Analyses III, IV, and V demonstrate that the subclassifications have different factorial compositions.

Additional information may be gained by examining the mean number of errors on all variables for the total group and for the subgroups (Table 8). Although the mean number of errors for some variables was small, errors were made on 26% of the consonant sounds evaluated in this study. In manner of production categories, 52% of the fricative sounds and 31% of the stop-plosive sounds were in error. These percentages are in agreement with the data reported by Spriestersbach and associates (*2*). The types of misarticulations most commonly exhibited were distortions, omissions, and distortions-nasal.

TABLE 6. Factor analysis V: variable weightings for 14 different articulatory measures, manometer ratio, and age for 19 subjects with low breath pressure ratios. Variables having a factorial weight of .50 or greater are indicated by an asterisk.

Variables	*Cumulative proportion of the total variance*					
	46% *Factor 1*	*62%* *Factor 2*	*72%* *Factor 3*	*80%* *Factor 4*	*86%* *Factor 5*	*91%* *Factor 6*
Nasality	.454	.217	.061	.544*	.513*	.009
Total errors	.872*	.074	.042	.059	.272	.214
Fricative errors	.855*	.047	.341	.022	.184	.056
Stop-plosive errors	.953*	.119	.209	.008	.069	.004
Glide errors	.511*	.029	.059	.262	.160	.772*
Nasal semivowel errors	.301	.033	.016	.069	.890*	.143
Substitutions, glottal	.068	.102	.039	.968*	.077	.075
Omissions	.707*	.502*	.083	.037	.058	.295
Distortions, nasal	.616*	.663*	.205	.312	.086	.117
Distortions	.277	.393	.671*	.040	.142	.353
Substitutions	.116	.498	.333	.114	.131	.695*
Substitutions, nasal	.391	.466	.642*	.042	.128	.244
Releasing errors	.927*	.082	.178	.054	.123	.281
Arresting errors	.892*	.001	.252	.018	.212	.086
Manometer ratio	.232	.120	.743*	.014	.135	.076
Age	.088	.830*	.134	.130	.008	.066

When subclassifications are examined, a rank ordering can be observed for total errors, manner of production categories, and severity ratings of nasality and articulation defectiveness. The low breath-pressure ratio group received the poorest scores, and the high breath-pressure ratio group received the highest scores on each of these variables. When type of errors is considered (that is, omissions or distortions) the type of distortion tends to be discriminating. Forty-three per cent of the total errors made by the low pressure group were distortions-nasal; however, less than 11% of the sounds misarticulated by the high pressure group were this type of error. Conversely, the high-pressure group and also the medium-pressure group exhibited a greater percentage of distortions-oral than did the low manometer ratio group. Regarding age in months, the three manometer ratio groups were similar with respect to monthly mean (111.16, 115.27, and 115.95), standard deviation (26.74, 29.00, and 28.37), and range (63–153, 62–169, and 60–172).

Discussion

CORRELATION MATRIX. Table 1 indicates that for the total group of subjects all the articulation variables are significantly related to either age or manometer ratios. It as been previously reported by Spriestersbach and Powers (*3*) that wet spirometer ratio and frequency of correct production of selected fricative and stop-plosive sounds are significantly related. Subtelny and Subtelny (*4*) also reported that there is a significant relationship between the intelligibility of plosive sounds and velopharyn-

TABLE 7. Comparison of the structure of six factors in five different factorial analyses. Only variables with weightings of .50 or greater are included.

Factor-analysis	*Factor 1*	*Factor 2*	*Factor 3*	*Factor 4*	*Factor 5*	*Factor 6*
I	nasality fricatives plosives distortions, nasal	glides semivowels, nasal omissions	distortions	glottal substitutions,	substitutions, nasal	substitutions
II	nasality fricatives plosives distortions, nasal manometer	glides semivowels, nasal omissions substitutions	distortions	glottal substitutions,	substitutions	substitutions, nasal
III	glides semivowels, nasal substitutions, nasal	glottal substitutions, distortions, nasal	fricatives plosives distortions substitutions	substitutions		plosives omissions
IV	nasality fricatives plosives distortions, nasal	glides substitutions	distortions	glottal substitutions,	substitutions, nasal	fricatives glides semivowels, nasal omissions age
V	fricatives plosives glides omissions distortions, nasal	omissions distortions, nasal age	distortions substitutions, nasal manometer	glottal substitutions, nasality	semivowels, nasal nasality	glides substitutions

TABLE 8. Means of total group and three subclassifications by pressure ratio on 17 variables.

Variable	Total Group		Subclassifications by pressure ratio					
			Low		Medium		High	
	Mean	% in error	Mean	% in error	Mean	% in error	Mean	% in error
Nasality	166.76		192.16		173.71		155.72	
Total errors	38.20	26	70.53	47	41.09	28	27.79	19
Fricative errors	17.26	52	26.95	82	18.84	57	13.81	42
Stop-plosive errors	17.29	31	35.11	63	19.36	35	11.76	21
Glide errors	2.58	9	4.68	16	2.80	10	1.94	7
Nasal semivowel errors	1.03	3	1.16	4	1.38	4	.76	2
Substitutions, glottal	.84	2	2.58	4	.86	2	.42	2
Omissions	11.05	29	17.26	24	11.54	28	9.22	33
Distortions, nasal	9.38	25	30.90	43	11.13	27	2.96	11
Distortions	11.35	30	8.47	12	12.11	29	11.51	41
Substitutions	4.91	13	6.58	9	5.70	14	3.95	14
Substitutions, nasal	.56	1	1.95	3	.77	2	.09	003
Releasing errors	19.27		39.37		21.30		13.00	
Arresting errors	18.78		28.47		20.79		15.03	
Manometer ratio	.818		.332		.754		.981	
Age (in months)	115.00		111.16		115.27		115.95	
Defectiveness	104.34		192.26		117.06		72.92	

geal opening. Although errors on fricative and stop-plosive sounds are indicative of inadequate velopharyngeal closure, as demonstrated by Morris and associates (*1*), other types of errors must be considered in evaluation of the total articulation problem.

It is evident that when subclassifications by manometer ratios are considered variation does exist in the relationship of manometer ratios to other articulation measures. Although the sample studied for the low manometer group was small and only one measure achieved the 5% level of significance, the correlations of the manometer ratios with the articulation measures were generally higher than for the other two subclassifications (medium and high ratios). Those articulation measures which were most highly related to manometer ratios for the low-pressure group would also seem to be related to velopharyngeal adequacy. For the medium pressure-ratio group, manometer ratios were significantly related to stop-plosive errors and glottal-stop substitutions at the 1% level of significance. Manometer ratios were not significantly related to any articulation variables for the high-pressure group.

Table 1 also demonstrates that age is significantly related to most articulation measures for the total group. When groups are subclassified, all but two articulation measures are significantly related to age for the high-pressure ratio group. The medium-pressure group also demonstrates several articulation measures which are significantly related to age. Nasal semivowels, omission, and substitution errors appear to be more directly related to age than to manometer ratios for this group. Only two articulation variables were significantly correlated with age for the low-pressure group. These were omissions ($r = -.51$) and distortions-nasal ($r = .47$).

It is evident that both age and manometer ratios are important in assessing the articulation defectiveness of children with cleft palates. For those individuals with poor breath-pressure ratios, inadequate velopharyngeal closure is the most predominant factor contributing to articulation defectiveness. For those subjects with high breath-pressure ratios, age appears to be more important than velopharyngeal closure in contributing to articulation defectiveness.

Factor Analysis. *Total Group.* When considering the total group of subjects in this study, it seems that the major factor contributing to articulation defectiveness is adequacy of velopharyngeal closure. Factor 1, which accounts for 60% of the total variance, is composed of major weightings on variables often identified with velopharyngeal inadequacy. As demonstrated in Analysis II, manometer ratios contribute a major weighting to this factor, as well as the variables nasality, fricatives, stop-plosives, and distortions-nasal.

A second and smaller factor contributing 14% of the total variance appears to be related to maturation of articulation skills. Glides, nasal semivowels, omissions, and substitutions contribute major weightings to this factor. Age also has its highest weighting on Factor 2. It is commonly accepted that a young child often omits consonant sounds in the early stages of acquisition of articulation skills. As a child progresses in these skills, substitutions occur.

A third and more specific factor accounts for 9% of the total variance. This factor is loaded almost entirely by distortions and appears to be related to a general inaccuracy of articulation skills. Other less important factors are represented by glottal-stop substitutions, substitutions-nasal, and substitutions.

The composition of the first three factors discussed above is consistent with those factors reported in a previous study in which multiple correlation techniques were utilized (*5*).

Subclassifications. The last three factor analyses were executed on the assumption that the relative contributions of factors in predicting defectiveness of articulation may vary with the adequacy of velopharyngeal closure as measured by breath-pressure ratios.

The high-pressure subgroup does not have a factorial composition similar to the total group nor to the other two ratio subgroups. Upon observation of Table 4 it does not seem that any one of the six factors consists primarily of variables related to velopharyngeal closure, which is to be expected if manometer ratios are to be considered a valid measure of velopharyngeal competence. Although Factor 3 has major weightings on variables which are commonly related to velopharyngeal closure, manometer ratios exhibit almost no weight value on this factor. It seems reasonable to conclude that velopharyngeal inadequacy does not play a significant role in the articulation defectiveness of individuals in this group. It is probable that individuals with high breath-pressure ratios exhibit articulation errors similar to children with functional articulation problems. Other variables which may contribute to the factorial composition may be a) the period of time that velopharyngeal adequacy has been present, b) dental deviations, and c) extent and effectiveness of remedial training.

The results of Analysis IV (medium-pressure group) are similar to the results of Analyses I and II. Factor 1, velopharyngeal closure, includes the same cluster of variables in all three analyses. Maturation indices seem to be accounted for in both Factors 2 and 6, while distortions, glottal-stop substitutions, and substitutions-nasal are again small and specific factors. In such a group with marginal oral breath-pressure ratios, one would expect to find some velopharyngeal insufficiency. In this group, however, other factors may also contribute to articulation defectiveness; namely, maturation, and general inaccuracy of articulation.

The number of subjects falling in the low-pressure group (Analysis V) is small, and therefore interpretation of the data must be undertaken with caution. However, trends for the identification of factors may be explored and a comparison of this group with other subclassifications and with the total group may be meaningful. Subjects with low pressure ratios seem to exhibit velopharyngeal closure factors (Factors 1 and 3) and maturational factors (Factors 2 and 6). The factorial matrix is not simple in structure, in that some variables, such as omissions, exhibit heavy loadings on both velopharyngeal and maturational factors. Such a finding is reasonable in that a child may omit a sound because he does not have enough oral breath pressure to produce it, or because he is slow in the acquisition of speech sounds. The analysis indicates that all variables contribute at least one major weighting to the six factors obtained.

Summary

The purpose of this study was to evaluate these hypotheses: a) more than one factor contributes to the articulation defectiveness of children with cleft plates, and b) different factors exist when subclassifications by manometer ratios are considered. Fourteen articulation measures, age, and manometer ratios were obtained for 154 subjects. Five different factor analyses were executed. The results indicate that for the total sample studied, six factors contribute to articulation defectiveness. The group with high manometer ratios did not demonstrate a velopharyngeal factor. Low and medium pressure-ratio groups demonstrated that a velopharyngeal inadequacy factor and a maturational factor contribute to articulation defectiveness. It is evident that in evaluating the articulation defec-

tiveness of children with cleft palates one must consider that differences exist within the population and that researchers must be aware of the above differences in future investigations.

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