Consistency of Articulation of Subjects with Cleft Palate

D. R. VAN DEMARK, Ph.D
Iowa City, Iowa

Early research studies in the field of articulation have indicated that, as a rule, children are inconsistent in their misarticulations of speech sounds. For example, Wellman and associates (*13*) found that the percent of correct articulatory productions increases as a function of age, as did Roe and Milisen (*8*). Spriestersbach and Curtis (*9*), in a review of studies done at The University of Iowa, indicated that individuals who misarticulated speech sounds typically do so inconsistently, that the inconsistencies are to be accounted for on a lawful basis, and that a need exists for rather detailed testing of any defective sound. Much of the research examining inconsistency of misarticulation has involved subjects with articulation problems classified as functional rather than those due to some structural deficit, such as cleft palate.

There is some information about cleft palate speakers, however. McWilliams (*5*) reports that the articulation of adult patients with cleft palate is highly inconsistent, and that most subjects were able to produce all consonant sounds correctly some of the time. Spriestersbach, Darley, and Rouse (*10*) also indicated that children with cleft palate tend to be highly inconsistent in articulatory performance. McDermott (*4*) in his investigation of /s/ production for 54 cleft palate individuals also examined consistency. He concludes that individuals with oral manometer ratios of .90 or better were significantly more consistent in producing a correct /s/ than were subjects with lower manometer ratios. His findings emphasize the importance of such factors as velopharyngeal incompetence, dental configuration, phonetic environment, syllabic function, and rate of utterance.

The present study was designed to investigate the use of measures of consistency of articulation proficiency in differentiating subgroups of cleft palate subjects and to examine consistency measures as a tool for clinical diagnosis and prognosis. (Although consistency may be defined in a variety of ways, for the purposes of this study the measure was defined as the percent *correct*.) The specific question asked was: Do articulation consistency scores vary with manometer ratios, age, severity of articulation defectiveness, and manner of production categories for various subgroups of cleft palate patients?

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Procedure

SUBJECTS. Subjects in this study were 154 children between the ages of 5 and 14 years with a congenital cleft of the lip, the palate, or both. No restrictions were made on the type of physical management used to close the palate cleft. None of the subjects had a hearing loss greater than 15 dB (ASA standards) in the better ear (500, 1000, 2000 hz) or showed evidence of gross neuromuscular impairment.

OBSERVATIONS. A standard sample of speech was elicited from each subject using a set of thirteen test sentences constructed for a previous study (*12*). These sentences contain a total of 149 consonant sounds: 56 plosives, 33 fricatives, 31 nasal semi-vowels, and 29 glides. Twenty-one consonant blends appear in various combinations. The sample was constructed so that the approximate frequency of occurrence of the various consonant sounds was equal to their relative frequency of occurrence in the English language, as determined from Jordan's (*3*) reclassification of the data of French, Carter, and Koenig (*1*). Each subject was asked to repeat the sentence after the experimenter, and the entire speech sample was tape recorded.

The recorded samples were prepared for judging in the following manner: each sample was edited to delete the voice of the experimenter, the order of presentation of the 13 sentences was randomized within each sample, and finally the total group of samples was randomized.

In addition, oral manometer ratios were determined for each subject using the Hunter oral manometer. Oral breath pressure ratios were computed by dividing the manometer reading obtained with nostrils open by the reading obtained with nostrils occluded. A bleed valve allowing a small leak of air was utilized to minimize the occurrence of tongue palate valving.

Age of the child was also noted.

ARTICULATION ANALYSIS. Articulation analysis of the tape recording of each subject's speech was made by the experimenter. In scoring articulation, each of the 149 test items was evaluated for correctness. If the item was incorrect the response was categorized according to the manner of production of the error sound (fricative, plosive, glide, nasal semi-vowel) as well as the type of error (distortion-oral, distortion-nasal, glottal-stop substitution, substitution, and omission). The reliability of the experimenter's judgments and further definition of these categories has been described previously (*12*).

A group of 22 judges (students in speech pathology), using the method of direct magnitude estimation, rated the articulation defectiveness of each sample (which contained all 13 test sentences). The reliability coefficient for averaged ratings of articulation was .95.

For each subject the articulation score for each of the 149 consonant sounds was placed on computer cards. An appropriate computer program using IBM 707 and 1401 computers was used to determine the number of

TABLE 1. Articulation consistency scores of manner-of-production categories for 154 subjects when only one variable (manometer ratios, age, and judged severity) was considered. Items are number of subjects (N) and per cent of correct plosives (pl), fricatives (fr), nasals (na), and glides (gl).

	N	pl	fr	na	gl
manometer ratios					
1.00 to 0.90	79	78.9	58.3	97.2	93.4
0.89 to 0.51	56	66.1	42.9	95.1	90.0
0.50 to 0.00	19	36.9	18.0	95.7	82.5
age					
5 to 7-11	44	52.4	33.4	92.7	83.8
8 to 10-11	64	73.6	48.0	96.8	93.2
11 to 15	46	78.6	61.1	98.8	94.3
severity					
least	51	91.2	75.5	99.2	97.9
moderate	67	70.7	42.6	96.7	92.7
severe	36	34.4	17.8	91.2	77.2

correct productions of each phoneme, and the number of correct plosives, fricatives, semi-vowels, and glides. The total number of subjects in each group was determined as well as the sum of correct articulation for each phoneme, the group average, and the percent of consistency of articulation. Percent of consistency of correct articulation was determined by dividing number correct by total number of phonemes.

SUBJECT CLASSIFICATION. The subjects were categorized by three schemes. After inspecting the range of judgments of articulation severity, subjects were arbitrarily assigned to one of the following categories: a) subjects with severity ratings of 1–50 (least severe), b) subjects with severity ratings of 51–150 (moderately severe), and c) subjects with severity ratings of 151–550 (severe).

They were also categorized according to chronological age: a) 5 years to 7 years, 11 months; b) 8 years to 10 years, 11 months; and c) 11 years to 15 years.

They were also placed into the following manometer ratio groups as suggested by Spriestersbach, Moll, and Morris (*11*): a) those subjects with manometer ratios of 1.00 to .90, b) those subjects with manometer ratios of .89 to .51, and c) those subjects with manometer ratios of .50 or below.

Table 1 presents the number of subjects in each of the criterion groups for manometer ratios, age, and severity of articulation. Table 2 presents the size and number of subgroups comprising various groups when manometer ratios, age, and severity of articulation were held constant.

Results and Discussion

Table 3 indicates the number of times each phoneme was tested, frequency of occurrence, the consistency of correct articulation, and the

TABLE 2. Number of subjects (N) and consistency scores for the manner of production categories of plosives (pl), fricatives (fr), nasals (na), and glides (gl), for defined subgroups.

manometer ratio	*age*	*severity*	*N*	*pl*	*fr*	*na*	*gl*
good	5 to 7-11	mild	4	89.3	75.8	98.4	96.6
		moderate	8	76.4	43.6	96.0	90.1
		severe	8	36.8	27.4	90.7	76.7
	8 to 10-11	mild	14	90.4	72.7	99.3	97.5
		moderate	17	75.6	44.9	95.8	93.1
		severe	1	48.2	15.2	87.9	79.3
	11 to 15	mild	19	91.9	79.4	99.5	99.5
		moderate	18	78.3	53.0	98.8	93.1
		severe	0	0	0	0	0
marginal	5 to 7-11	mild	1	89.3	60.6	93.5	100.0
		moderate	6	63.1	43.4	94.6	96.0
		severe	11	38.0	19.0	86.8	74.6
	8 to 10-11	mild	1	89.3	60.6	93.5	100.0
		moderate	14	73.0	41.3	97.9	95.8
		severe	3	50.0	21.2	87.1	80.5
	11 to 15	mild	7	92.6	73.6	99.5	98.0
		moderate	7	68.1	45.4	98.6	89.7
		severe	2	29.5	12.1	96.8	84.5
poor	5 to 7-11	mild	0	0	0	0	0
		moderate	0	0	0	0	0
		severe	6	26.8	10.1	96.2	78.7
	8 to 10-11	mild	1	87.5	72.7	100.0	89.7
		moderate	5	58.6	30.3	94.8	92.4
		severe	4	25.4	9.1	95.2	81.0
	11 to 15	mild	0	0	0	0	0
		moderate	2	25.0	7.6	95.2	81.0
		severe	1	8.9	6.1	96.8	58.6

consistency of incorrect articulation for the total group of 154 subjects. The percent of consistently correct manner of production categories also is given. Consistency of incorrect articulation was defined as failure to produce a given phoneme in any contexts. For example, two subjects (1.3%) failed to produce an adequate /t/ phoneme in any context and, for the total group of subjects, the /t/ phoneme was correctly produced 67.9% of the time.

As pointed out previously, the frequency of the phonemes tested varied with the frequency of their occurrence in the English language and there-

TABLE 3. Number of times each phoneme was tested, consistency of correct articulation, and consistency of incorrect articulation for the total group of 154 subjects. Percentages of consistently correct productions are also given for the different manner-of-production categories.

phoneme	*frequency of occurrence*	*% consistently correct*	*% consistently in error*
plosives (pl)			
t	23	67.9	1.3
d	12	66.6	3.2
p	4	81.3	4.5
b	4	84.2	1.3
k	9	63.9	8.4
g	4	67.3	13.6
category percentage		69.0	
fricatives (fr)			
f	5	74.1	9.1
v	4	69.1	12.9
s	11	23.7	38.9
z	5	32.4	40.9
ʃ	1	44.6	56.5
ð	6	68.2	7.8
θ	1	51.9	48.1
category percentage		47.7	
nasals (na)			
m	9	98.8	—
n	20	97.1	—
ŋ	2	75.6	12.3
category percentage		96.2	
glides (gl)			
l	6	84.5	3.2
r	5	80.5	7.1
j	5	92.3	—
w	7	96.6	—
h	5	98.3	—
ʍ	1	95.4	4.5
category percentage		90.8	

fore those phonemes infrequently tested, such as /ʃ/ and /θ/, appear to have a higher percentage of consistency of error scores. Of those phonemes tested four or more times in this speech sample, only four phonemes, /g/, /v/, /s/, /z/, were consistently in error (never correctly produced) more than 10% of the time. The percentage of consistency of error for the /s/ phoneme, 38.9%, is similar to the finding of Nelson (7), who reported that 46% of his functional articulation subjects in grades 1 through 6 failed to produce /s/ correctly. Certainly most of these subjects in the present study were able to produce a phoneme correctly at least some of the time, even when age and assessment of velopharyngeal closure were disregarded.

Since the consistency-of-error percentages were small, the consistency of the type of error for each phoneme was not evaluated.

In manner-of-production categories, fricatives showed the lowest consistency score, followed by plosives, glides, and nasals. If one compares consistency scores on the various phonemes with the acquisition of sound development reported by Templin and Davis, reported in Johnson and others (*2*), there is a striking similarity. There also is similarity between trends for those sounds reported most frequently misarticulated (*2*) and those sounds with the lowest consistency scores in this study.

To examine the consistency scores of the total group more thoroughly, distributions were made of the number of correct productions of each phoneme. For the majority of speech sounds, the distributions of correct productions were skewed to the right, indicating that subjects tended to be "consistently correct" more often than "consistently in error". The converse was true for /s/, /z/, and /ʃ/. In manner-of-production categories, the distributions of correct productions also were skewed to the right for plosives, glides, and nasal semi-vowels. Fricatives showed no skewness and the distribution of scores appeared flat.

In Table 1, only one variable at a time (manometer ratios, age, or, indeed, severity) was utilized in subclassifying the total sample. Consistency scores were determined when only that variable, considered in three categories, was evaluated. It appears that, if only one measure is used in the prediction of consistency scores, a judged sample of speech is the most adequate. It will be noted that the 51 subjects who were rated as least severe in articulation defectiveness exhibited the highest percentage of consistency on all manner of production categories. Likewise, those subjects with the most severe rating of articulation defectiveness had the lowest percentage of consistently correct production in the manner of production categories.

When only age is considered, there appears to be little difference between groups 2 and 3 (all subjects over eight years of age), with the exception that fewer fricatives are consistently correctly produced by the younger group. For those subjects under eight (group 1), all manner of production categories had lower consistency scores.

When manometer ratios are considered, it appears clear that consistency scores decrease, especially for plosive and fricative sounds, as the manometer ratio decreases.

Table 2 allows comparison of consistency scores achieved for manner of production categories for the 27 subgroups. It should be noted that in four subgroups there are no subjects and that in several other subgroups the N is so small that interpretation is almost meaningless. Therefore, caution must be taken in interpreting these data. However, the following observations and interpretations seem plausible:

a. For those sounds requiring oral breath pressure, the consistency scores tend to decrease when manometer ratio decreases. A high manometer ratio itself does not assure high consistency scores on pressure sounds. For example, the subgroup who had good ratios, were of the youngest age

group, and ruled most severe, generally had low consistency on pressure sounds even though this group had good manometer ratios. This group, however, has a higher consistency score than does the same age group with severe ratings and poor manometer ratios (only manometer ratios differ).

b. Subjects with the highest consistency scores achieved the least severe rating of articulation defectiveness.

c. The largest subgroup of subjects were those older subjects who achieved good closure and good speech.

d. Subjects younger than 8 years of age, even though they have good manometer ratios, more likely than not are rated as having moderate to severe articulation problems. Only 20% received good articulation ratings.

e. The majority of children with good manometer ratios and who are between the ages of 8 and 11 have a moderate articulation problem, but unlike younger children, few are rated as having severe articulation problems.

f. For subjects with good manometer ratios who are older than age 11, over 75% have good articulation ratings while the remainder have a moderate articulation rating.

g. For subjects with marginal manometer ratios who are younger than age 8, the majority have poor articulation with some exhibiting a moderate articulation problem. Only one subject achieved a good articulation rating and he exhibited a relatively low consistency score on the production of fricative sounds.

h. For subjects achieving marginal manometer ratios and who are between the ages of 8 and 11, the majority have a moderate articulation problem. Some in time may achieve good articulation while others remain poor.

i. Approximately 50% of the subjects who were over 12 and who obtained marginal manometer ratios achieved good articulation ratings. Their percent of inconsistency scores also were among the lowest of the subgroups.

Implications

These findings indicate that even though a young child with a marginal manometer ratio exhibits poor articulation he may exhibit some degree of improvement by the time he is 15 years of age. In the older age group with marginal ratios, approximately 50% of the subjects achieved good articulation. Such a finding needs to be considered carefully when criteria regarding the decision for secondary surgical management are defined. Perhaps information about articulation consistency collected over a period of time for an individual may be helpful in predicting whether secondary management will be needed.

These data may have relevance in the further definition of a standard for normal articulation. For example, in this study, subjects who were judged least severe in articulation defectiveness achieved consistency

scores of 91% correct plosive production, 75% correct fricative production, and nearly 100% correct glide and nasal semi-vowel production. The inference can be made that some of that group have articulation problems so mild that listeners may consider them to be normal speakers. It would appear worthwhile to determine whether these subjects can be considered as having speech which is "normal" to the unsophisticated listener. If so, then a measure of relative normalcy of speech through the use of consistency scores can be made.

The use of consistency scores for group data appears to have some limitations in light of avaliable information. Preferably the articulation sample should be fairly large and thus more time-consuming to score than a small sample. Group comparisons become difficult to make, especially for specific phonemes, and much valuable information about a specific subject's performance may be overshadowed by group trends. Consistency scores seem to be especially appropriate for evaluating the performance of an individual over a period of time.

More importantly, by examination of the consistency protocol, guidelines for remedial procedures can be established. For example, Figure 1 demonstrates a protocol for an individual subject. It is obvious that this subject articulates /t/ and /d/ with high consistency, he does not articulate an adequate /g/ in any instance throughout the test, but he articulates an adequate /k/ 60% of the time. The /s/,/z/, and /ʃ/ sounds are consistently in error. By more thorough examination of the specific subject's response a clinician can determine in what phonetic environments a sound is in error or produced correctly. With such a protocol a logical approach to therapy for the above individual would appear to begin with remedial training to strengthen the /k/ sound followed by work on the /g/ cognate. Similarly those sounds which are consistently in error may be examined more thoroughly through the use of stimulation testing. Consistency scores seem to be especially appropriate in comparison of individual performances.

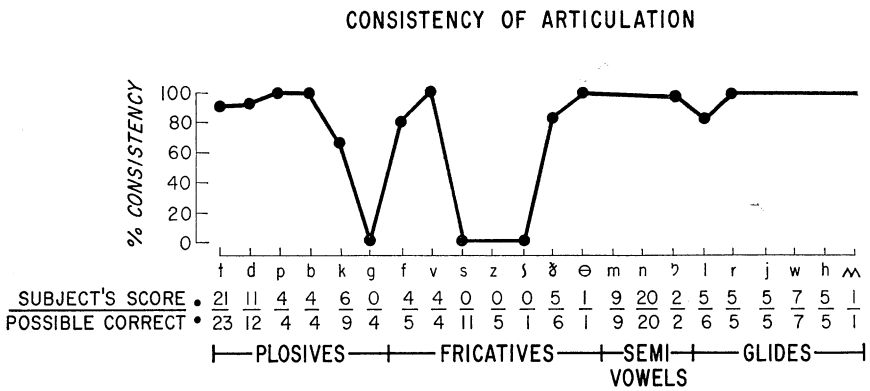

FIGURE 1. An illustration of a given subject's protocol demonstrating his consistency scores. (Semi-vowels listed here are nasals.)

Summary

The purpose of this study was to evaluate the usefulness of a consistency score (defined as percent correct) in the subclassification of individuals with cleft palates. Age, manometer ratios, and severity of articulation defectiveness were obtained for 154 cleft palate subjects. Articulation errors were scored and consistency of correct articulation was determined for various groups. The results indicate that consistency of correct articulation does in fact discriminate among the various groups. Consistency scores improve as age and manometer ratios increase. The use of consistency scores appears meaningful in comparing individual subjects with other subjects who have the equivalent manometer ratios and are of the same age. Moreover examination of an individual subject's consistency protocol enables the clinician to establish a logical approach to remedial procedures.

reprints: *D. R. Van Demark, Ph.D.*
Department of Otolaryngology and Maxillofacial Surgery
University Hospitals
Iowa City, Iowa 52240

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