Speech Sound Discrimination Skills of Seven- and Eight-Year-Old Cleft Palate Males

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Several authors (*4, 15, 23*) believe that the ability to make a distinction or comparison between closely related speech sounds must precede the production of these sounds. In order for a child's phonological skills to become increasingly differentiated, it is hypothesized that he must recognize certain acoustic patterns as different from others. A considerable amount of research has been conducted in the past few years (*7, 8, 17*) to determine at what age the child begins to discriminate speech sounds. Results indicate that the potential to begin sorting phonemic variations into separate categories exists within the first year of the child's life.

Locke (*15*) believes discrimination of acoustic patterns must be based on a comparison of the incoming perceptual event with the individual's stored repertoire of learned acoustic events. Eventually, the child learns to associate individual speech sounds with the appropriate vocal-motor movements used in producing them (*15*). These associations are then stored for future comparisons (*4, 13*). Hardy (*10*) feels that, once speech has been learned, the articulators are no longer totally dependent upon the auditory process for correct functioning. During the learning process, however, refinement of speech production and narrowing of the limits of acceptance of correct production is a function of improved speech discrimination and learning (*10*).

It is hypothesized that, a prerequisite for the normal development and refinement of speech sound discrimination skills, is a relatively stable level of hearing sensitivity in the child. It is well documented (*18, 22, 25, 26*) that children with cleft palate, particularly when they are very young, have a higher incidence of hearing loss than normal children. Generally, the majority of the individuals with clefts have hearing losses which are fluctuating, bilateral, conductive, and related to middle ear pathology (*11, 14, 26*). The fluctuating nature of the cleft palate child's hearing sensitivity during the important speech developmental years

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might interfere with his speech sound discrimination development. The child with a cleft palate probably fails to respond to much of the auditory stimulation from the environment as a result of these fluctuating hearing losses. Consequently, his ability to make comparisons between closely related speech sounds may not be as accurate as that of a child without a cleft palate.

This study was designed: a) to compare the speech sound discrimination skills of a group of seven- and eight-year-old cleft palate and noncleft palate males; b) to determine if there is any difference in speech sound discrimination abilities among cleft palate males who have a positive history of otological pathology versus those who have never been diagnosed as having had any middle ear pathology; and c) to ascertain if there is any difference in speech sound discrimination skills among cleft palate males who have been diagnosed as having velopharyngeal competency versus those diagnosed as demonstrating velopharyngeal incompetency.

Methods

Subjects

The subjects were 32 male children, 16 noncleft and 16 with cleft palates. One-half of the subjects in each group were between seven years 0 months and seven years 11 months of age ($\bar{x}$ = 7 years 5 months in both groups) and the other half were between eight years 0 months and eight years 11 months of age ($\bar{x}$ = 8 years 7 months in both groups). All subjects came from monolingual homes in which General American English was spoken. The mean number of siblings for the noncleft and cleft palate subjects was 2.25 and 3.81 siblings, respectively. To control the variable of regional dialect, all subjects were selected from within a 100-mile radius of Madison, Wisconsin.

Procedures

All subjects were of normal intelligence as measured by the Columbia Mental Maturity Scale (3). No subject was judged to have any gross deviation in structural or functional integrity of the maxilla, mandible, lips, tongue, or oral pharynx other than the surgical repair of the maxillofacial cleft.

Pure tone audiometric tests were administered to all subjects. Subjects were selected for the study if, on the day of testing, their air conduction threshold average was <20 dB (ISO, 1964) in the better ear for the speech frequencies (500, 1000, and 2000 Hz). The mean better ear average and standard deviation for the noncleft and cleft palate group was ($\bar{x}$ = 4.56 dB, S.D. = 3.65 dB and ($\bar{x}$ = 5.75 dB, S.D. = 5.73 dB) respectively. While the cleft palate children's better ear averages were <20 dB (ISO, 1964) on the day of testing, the majority had experienced hearing losses in excess of 20 dB in the past.

From past and current medical records, it was learned that eight cleft palate children had been or presently were diagnosed as having some type of middle ear pathology, specifically serous otitis media. The other eight cleft palate subjects had never been diagnosed as having otitis media or any other abnormal middle ear pathology. In accordance with the otological histories, the cleft palate subjects were placed within positive or negative otological pathology subgroups. Otological histories for the noncleft children were obtained from parental interviews. Subjects were excluded from the study if they had any history of abnormal middle ear pathology.

The Iowa Pressure Articulation Test (IPAT) (*19*) was used in combination with a rating scale of nasality to assess subjectively the cleft palate subjects' velopharyngeal competency for speech. Subject performance on the IPAT was judged from audio tape-recordings. The nasality ratings were made from two 30-second language samples. A seven-point, equal appearing interval scale, with the rating of 1 indicative of no nasality and a rating of 7 indicating severe hypernasality, was used to make the ratings.

Three experienced speech pathologists made the speech evaluations. Subjects' scores on the IPAT and their nasality ratings represented the mean score of the three judges. Criterion levels were arbitrarily derived from the distribution of test scores on the IPAT for placing subjects into velopharyngeal competent and incompetent groups. Velopharyngeal competent subjects correctly produced $\geqslant$80% of the 43 test items. Velopharyngeal incompetent subjects produced $\leqslant$68% of the 43 items correctly. Nasality ratings were used only in cases of questionable subject placement.

Examiner reliability, as determined in independent retest of four randomly selected subjects, was considered satisfactory. The percentage of agreement, for the judged error scores on the IPAT among the three judges for the noncleft and cleft palate subjects, was .90 and .79 respectively.

Speech Sound Discrimination Task 68-F (SDT 68-F) (*23*) was employed to assess the discrimination abilities of the subjects. It has been suggested recently (*2, 9, 23*) that certain important modifications had to be made in the conventional tests of auditory discrimination (*27, 28, 30*) in order to obtain a more sophisticated and optimal assessment of phonemic discrimination in children. The following modifications were incorporated into the design of SDT 68-F for this study: a) replacement of the overt same-different judgment requirement inherent in the A-X paradigm with an A-B-X paradigm which requires minimal instructions; b) inclusion of repeated contrast pairs to provide the subject with more information on which to base his discriminatory decision, along with traditional minimal contrast pairs (a repeated contrast pair consists of two CVC syllables in which the same phonemic contrast occurs twice; for example,

/pæp/ - /tæt/ is a repeated contrast pair in which the phonemic contrast /p/ - /t/ occurs in both initial and final positions); and c) multiple testing sessions.

SDT 68-F consists of six separate test lists. Each test list is composed of seven repeated contrasts and seven minimal initial and seven minimal final pairs in which the phonemic contrast occurs in either the initial or final position only. Subjects were required to make discriminations on the basis of place of articulation or voicing contrasts. When place of articulation discriminations were required, manner of articulation was held constant. For contrasts involving voiced-voiceless tests pairs, manner and place of articulation were held constant. Plosives, fricatives, nasals, and affricates were tested. All stimulus items were recorded on an Ampex stereo tape recorder by a male speaker whose dialect was Upper Midwestern. The complete list of test pairs is shown in the Appendix.

SDT 68-F was administered individually through two speakers via an Ampex Model 755 stereo tape recorder output system. The test items were presented at 70 dB SPL. Each child received two test lists. The first and second test administrations were separated by a two-hour time interval. Selection of the lists and the order of presentation was randomized. Testing was conducted in a sound suite in the following manner: A ready signal bell sounded from the left speaker followed one second later by item A of a test pair from the same speaker. Item B of the pair was then presented one second later from the right speaker. The question, "Who said X?" then occurred from both speakers. The child's task was to match X to A or B by pointing to the appropriate speaker. Approximately five minutes were required to complete a test list. To increase motivation during testing, token reinforcers were provided upon completion of the listening tasks.

Results

Quantitative Analyses

The number of incorrect responses produced on test administration 1 and 2 of SDT 68-F is reported in Table 1. Inspection of these data reveals that the cleft palate subjects consistently produced a larger mean number

TABLE 1. Mean number of speech sound discrimination errors on SDT 68-F.

subjects	*test adm. 1*		*test adm. 2*		*test adm. 1 and 2*	
	mean	*s.d.*	*mean*	*s.d.*	*grand mean*	*s.d.*
cleft palate ($N = 16$)......	3.562	2.47	3.312	2.72	3.347	2.56
noncleft palate ($N = 16$)..	1.375	1.31	1.312	.79	1.343	1.06

of errors than the noncleft subjects. The percentage of discrimination errors, categorized according to chronological age, is illustrated graphically in Figure 1. Examination of the figure indicates that the cleft palate subjects consistently produced a greater percentage of error at both age levels. Differences in speech sound discrimination performance between

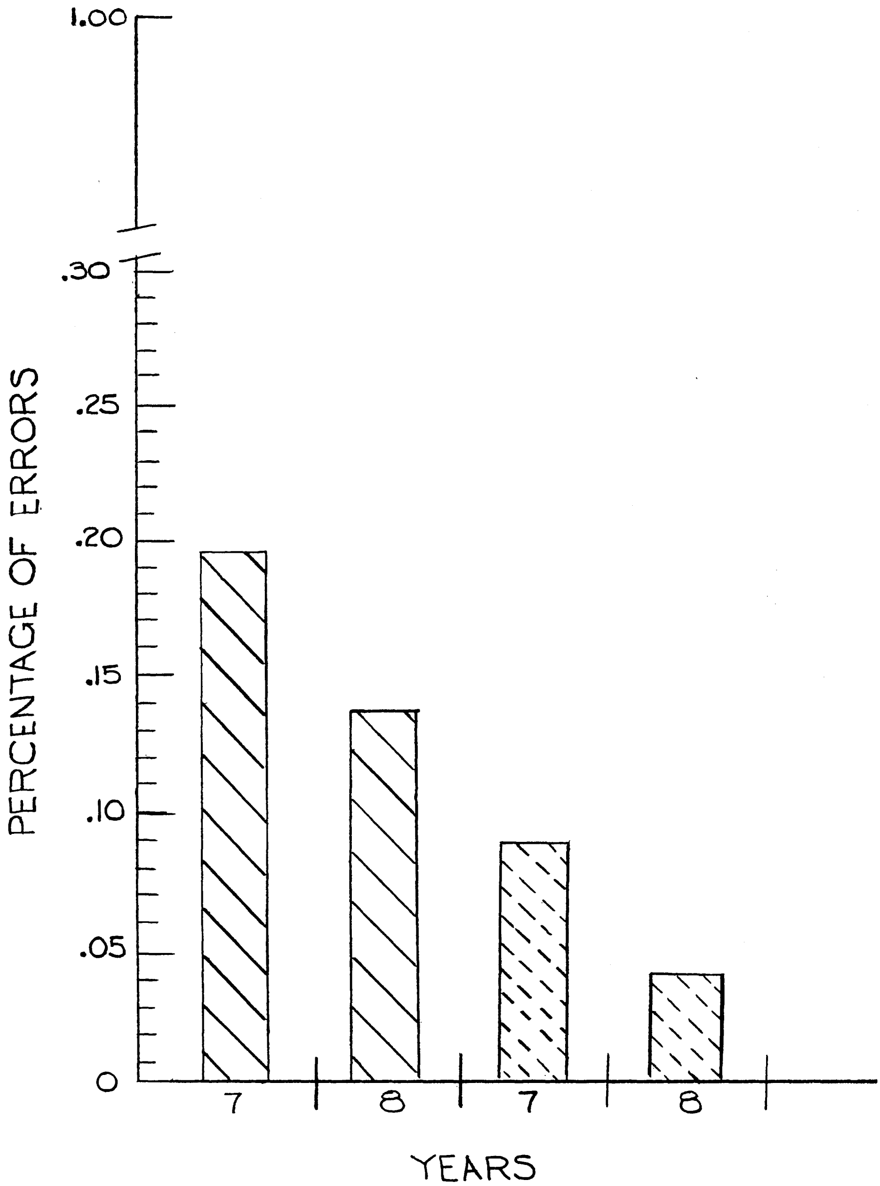

FIGURE 1. Percentage of error on SDT 68-F according to subject group and chronological age level. (Cleft palate subjects are shown by solid lines. Noncleft palate subjects are shown by broken lines.)

the two subject groups, the two chronological age levels, and the two test administrations of SDT 68-F were evaluated statistically by a three factor mixed effects repeated measures analysis of variance (*31*). This analysis showed a significant main effect for subject groups ($F = 9.808$, $p < .01$), no significant main effect for chronological age levels ($F = 2.325$, $p > .05$), or test administration ($F < 1$, $p > .05$), and no significant interactions ($F < 1$, $p > .05$). The significant F ratio for the subject group factor was the result of the noncleft palate subject's superior performance on SDT 68-F.

In an attempt to describe what may be contributing to the cleft palate subjects' poorer performance on the discrimination task, sound discrimination errors were categorized according to: a) the subjects' otologic history, b) velopharyngeal competency assessment, and c) a combination of otologic history and velopharyngeal functioning for speech. These data are presented in Tables 2, 3, and 4. A review of the data reveals the following: a) cleft palate subjects who were diagnosed as having negative otological histories performed better as a group on SDT 68-F; b) cleft palate subjects classified as velopharyngeal competent for speech performed better on the discrimination tasks; and c) cleft palate subjects diagnosed as having negative otological histories and velopharyngeal competency for speech were better able to discriminate speech sounds than subjects with any other combination of otological history and velopharyngeal functioning ability. Statistical analyses of the group means were impossible because of the limited and/or uneven number of cleft palate subjects in each cell and because the variables of otological history and velopharyngeal competency were not independent of one another in this study.

TABLE 2. Sound discrimination errors of cleft palate subjects categorized according to otological history.

otological history	*mean error*	*standard deviation*
positive otological history ($N = 8$)	4.06	2.59
negative otological history ($N = 8$)	2.81	2.38

TABLE 3. Sound discrimination errors of cleft palate subjects categorized according to velopharyngeal functioning ability.

velopharyngeal assessment	*mean errors*	*standard deviation*
velopharyngeal incompetency ($N = 6$)	4.83	2.82
velopharyngeal competency ($N = 9$)	2.72	2.05

TABLE 4. Sound discrimination errors of cleft palate subjects categorized according to otological histories and velopharyngeal functioning abilities.

otological and velopharyngeal combinations	*mean error*	*standard deviation*
positive otological history		
velopharyngeal incompetency ($N = 3$)........	5.16	2.75
velopharyngeal competency ($N = 4$)..........	3.87	2.65
negative otological history		
velopharyngeal incompetency ($N = 3$)........	4.50	3.46
velopharyngeal competency ($N = 5$)..........	1.80	.24

Qualitative Analyses

Additional analyses were conducted to determine if the cleft palate subjects' discrimination errors differed qualitatively from the noncleft subjects. The percentage of error on SDT 68-F, as a function of place of articulation versus voiced-voiceless contrasts for each subject group, was calculated. Similar error patterns existed for both cleft and noncleft subjects. Place of articulation contrasts were more difficult to discriminate than voicing contrasts. Sound discrimination errors were then categorized according to phonetic manner class. These data are presented in Table 5. A two factor mixed effects repeated measures analysis of variance design (*31*) was used to analyze the error differences among phonetic manner classes for both subject groups. The analysis revealed a significant main effect for subject groups ($F = 9.808$, $p < .01$), no significant main effect for phonetic manner class ($F = 2.23$, $p > .05$), and a significant subject group by phonetic manner class interaction ($F = 4.41$, $p < .01$). The significant F ratio for the subject group factor has been previously discussed. To evaluate the significant interaction, components analyses (*12*) were computed between each subject group on the mean percentages of error for each phonetic manner class. No significant differences were found between subject groups on the plosive or fricative contrasts. The noncleft palate subjects, however, were significantly better than the cleft palate subjects at discriminating affricates ($t = 4.00$, $p < .05$) and nasals ($t = 27.29$, $p < .01$).

Separate item analyses were also performed. Error rates for the individual sound contrasts are displayed in Table 6. Examination of the data indi-

TABLE 5. Percentage of items missed on SDT 68-F according to phonetic manner class.

subjects	*phonetic manner class*			
	plosive	*fricative*	*affricative*	*nasal*
cleft palate....................	11.6	18.4	21.9	37.5
noncleft palate................	1.8	10.6	9.4	3.1

TABLE 6. Percentage of error for individual sound contrasts on SDT 68-F.

place of articulation contrasts	*percentage error*		*voice-voiceless contrasts*	*percentage error*	
	noncleft	*cleft palate*		*noncleft*	*cleft palate*
p–t	—	12.5	p–b	—	25.0
t–k	—	15.6	t–d	—	6.2
b–d	6.2	12.5	k–g	3.1	—
d–g	3.1	9.4	f–v	12.5	15.6
f–θ	50.0	34.4	θ–ð	9.4	15.6
θ–ʃ	6.2	12.5	s–z	3.1	9.4
v–ð	18.7	25.0	ʃ–ʒ	—	21.9
ð–z	3.1	21.9	tʃ–dʒ	9.4	21.9
s–ʃ	—	12.5			
z–ʒ	3.1	15.6			
m–n	3.1	37.5			

cates that two contrasts /f/–/θ/ and /f/–/ð/ accounted for 73.3% of all the nonclefts discrimination errors on place of articulation contrasts. Within the cleft palate group three contrasts, /f/–/θ/, /v/–/ð/ and /m/–/n/ constituted 47.1% of all discrimination errors on place of articulation contrasts. Similar results were apparent for both subject groups with the exception of the high error rate on nasal contrasts for the cleft palate group. Three individual test pairs, /f/–/v/, /θ/–/ð/ and /tʃ/–/dʒ/ accounted for 83.3% of all errors on the voicing contrasts for the noncleft subjects. Somewhat different findings occurred in the cleft palate group. Three contrasts, /p/–/b/, /ʃ/–/ʒ/ and /tʃ/–/dʒ/ constituted 60.5% of all their discriminatory errors on the voicing contrasts.

Discussion

The data clearly reveal that the cleft palate child in this study is functioning below the level of the noncleft palate child in speech sound discrimination ability. Subjects with cleft palate, on the average, produced over twice as many errors (mean = 3.347, standard deviation = 2.56) as the noncleft subjects (mean = 1.343, standard deviation = 1.06) on SDT 68-F. It is also apparent from the data displayed in Figure 1 that speech sound discrimination ability is an age related variable (*29*) for both subject groups.

The relationships between speech sound discrimination ability, otological history and velopharyngeal functioning ability was examined in an attempt to account for the poorer performance by the cleft palate children on the discrimination task. Apparently, a combination of velopharyngeal incompetency for speech and a positive history of otological pathology adversely affect speech sound discrimination performance. It was not possible, however, to determine the extent to which each of these concomitants affected the cleft palate child's discrimination ability.

It is hypothesized that the mutual occurrence of velopharyngeal incompetency, otologic pathology, and speech sound discrimination difficulty may be attributed to the following conditions: a) the presence of anatomical and/or physiological deviation in the levator palatini muscle can lead to velopharyngeal incompetency for speech (*6*); b) similar anatomical and/or physiological deviations in the tensor palatini muscle can lead to eustachian tube dysfunctioning (*6*). Eustachian tube dysfunction in turn can be causally related to middle ear pathology; specifically otitis media (*1, 16, 21*); c) consequently, the presence of fluid in the middle ear can lead to a loss of hearing which is usually bilateral (*22, 26*), and in the range of 20–40 decibels (ISO, 1964) (*5, 20, 24*). Condition b and c, if they occur often enough during the cleft palate child's early speech development years, could interfere with or prevent the child's learning to recognize certain speech sounds as different from others. Consequently, the child with a cleft palate may still experience difficulty in discriminating certain speech sounds at seven or eight years of age.

The implications of these particular findings and speculations are important for two reasons: a) the cleft palate child's difficulty in discriminating speech sounds may create a situation in which his ability to correctly compare the verbal production of others with his own is also defective, and b) his ability to correctly produce these speech sounds may also be impaired.

The only qualitative difference between the cleft and noncleft subjects' performances on SDT 68-F involved the phonetic manner class contrasts which were the most difficult to discriminate. Analysis of the discrimination errors, arranged according to phonetic manner class within each subject group, failed to reveal any significant differences. When the phonetic manner class errors were compared between the two subject groups, however, significant differences were found. Cleft palate subjects found the affricative and the nasal contrasts the most difficult to correctly discriminate. The difficulty the cleft palate children experienced in discriminating affricative contrasts is not unusual or surprising. A similar finding was reported by Rudegeair and Kamil (*23*) with a group of noncleft palate children. It is interesting that the cleft palate children experienced the greatest difficulty in discriminating the nasal contrast /m/ - /n/. This difficulty may be attributed to the combination of hypernasality, nasal emission, and nasal substitution which characterize the speech of some cleft palate children.

The proposed relationship between velopharyngeal closure, otological history, and speech sound discrimination skills must be considered speculative and no definite conclusions can be drawn at this preliminary stage of study. Future investigations employing multiple regression analysis need to be conducted to determine the extent to which each of these concomitants affects the cleft palate child's speech sound discrimination skills.

Summary

Speech sound discrimination skills of 16 seven- and eight-year-old cleft palate children were evaluated and compared with the speech sound discrimination skills of 16 seven- and eight-year-old noncleft children. Within the cleft palate group, the effects of velopharyngeal competency and incompetency and the presence or absence of a history of middle ear pathology were evaluated in relation to speech sound discrimination performance. The findings showed that the discrimination skills of cleft palate children were significantly inferior to those of the noncleft palate group. Cleft palate children who were considered velopharyngeal incompetent for speech and had experienced a history of middle ear pathology encountered the most difficulty in discriminating speech sounds. Possible explanations for the mutual occurrence of velopharyngeal incompetency, a history of middle ear pathology and an apparent difficulty in the ability to discriminate speech sounds are presented in this paper.

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APPENDIX

Complete List of Test Pairs Used in SDT 68-F

Place of Articulation Contrasts

Repeated Contrast Pairs	Minimal - Pair Initial	Minimal - Pair Final
pæp--tæt	pæp--tæp	pæp--pæt
tæt--kæk	tæt--kæt	tæt--tæk
tæt--čæč	tæč--čæč	čæt--čæč
fæf--θæθ	fæf--θæf	fæf--fæθ
θæθ--sæs	θæs--sæs	sæθ--sæs
sæs--šæš	sæs--šæs	sæs--sæš
bob--dod	bob--dob	bob--bod
dod--gog	dog--gog	god--gog
dod--ǰoǰ	dod--ǰod	dod--doǰ
mom--non	mom--nom	mom--mon
vov--ðoð	vov--ðov	vov--voð
ðoð--zoz	ðoð--zoð	ðoð--ðoz
zoz--žož	zoz--žoz	zoz--zož

Voiced - Voiceless Contrasts

pæp--bæb	pæp--bæp	pæp--pæb
tot--dod	tod--dod	dot--dod
kæk--gæg	kæg--gæg	gæk--gæg
fæf--væv	fæf--væf	fæf--fæv
θæθ--ðæð	θæθ--ðæθ	θæθ--θæð
sos--zoz	sos--zos	sos--soz
šoš--žož	šoš--žoš	šoš--šož
čoč--ǰoǰ	čoč--ǰoč	čoč--čoǰ