

# **PHONETIC CONTEXT AND HYPERNASALITY IN TWO GROUPS OF CLEFT PALATE SPEAKERS**

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## **ABSTRACT**

This study was designed to evaluate the effects of certain phonetic contexts upon the perception of nasality in seven mildly nasal and seven moderate-severely nasal cleft palate speakers. The speech tasks consisted of the production of (a) four isolated vowels, (b) the same four vowels in consonant-vowel-consonant (CVC) syllables, and (c) sentences loaded with the same four vowels. The psychological scaling procedure of equal-appearing intervals was used to assess the severity of nasality. The results indicated that, for both groups of speakers, nasality is judged to be increasingly more severe from isolated vowels to CVC syllables to sentences. However, the magnitude of the differences across task complexity was significantly greater for the moderate-severely nasal cleft palate group. For both groups, severity of hypernasality was dependent upon the vowel and, to a lesser extent, the consonant produced.

In addition, backward versus forward playback was assessed for a connected speech task. Results indicated that mildly hypernasal cleft palate speakers are judged to be more nasal when speech is presented in backward playback than forward playback, while nasality judgments do not differ for the two modes of presentation for moderate-severely hypernasal cleft palate speakers.

## **INTRODUCTION**

Previous research has indicated that judged severity of hypernasality varies with phonetic context and type of speaker (Van Hattum, 1958; Lintz and Sherman, 1961; Carney and Sherman, 1971; and Moore and Sommers, 1973). However, studies which have assessed severity of hypernasality in cleft palate speakers have, for the most part, included speakers with a wide range of hypernasality (Spriestersbach and Powers, 1959; Carney and Sherman, 1971; and Moore and Sommers, 1973). Clinical judgments of hypernasality are frequently made on speakers with cleft palate in phonetic contexts, which are less than conversational. It was reasoned that by studying the effect of phonetic context on pre-determined subgroups of cleft palate speakers with varying degrees of nasality, some information might be provided to speech pathologists in making clinical management decisions which are dependent upon the judged severity of nasality in persons with cleft palate.

Therefore, the major purpose of this study was to assess the effect of phonetic context on the severity of judged hypernasality in two groups of cleft palate speakers; namely, a group of mildly hypernasal speakers and a group of moderate-severely hypernasal speakers. A further purpose was to assess differences in judged severity of hypernasality in forward versus backward presentation mode for these two groups of cleft palate speakers.

### METHOD

**Subjects.** The subjects used in this study were fourteen cleft palate speakers. These subjects were selected from nineteen cleft palate speakers clinically diagnosed as hypernasal. From the tape recordings of a standard reading passage ('Lazy Jack') in forward play by these nineteen speakers, four graduate students in speech pathology, who had experience in assessing severity of resonance distortion, judged the samples according to an equal appearing interval scale of 'one' to 'seven', where 'one' represented very mild hypernasality, and 'seven' represented severe hypernasality. On the basis of these judgments, seven speakers with mild hypernasality (mean rating of 1-3), and seven speakers with moderate-severe hypernasality (mean rating of 4-7) were determined. All subjects had essentially normal hearing, that is, no loss greater than 20dB ISO for the better ear at 500, 1000, and 2000 Hz. Articulatory characteristics of the subjects were judged to be within normal limits for the consonants and vowels of interest in this study. The only articulation error which was allowed was nasal air emission.

**Speech Tasks.** Each subject produced the following speech tasks: (1) isolated vowels (/i/, /ae/, /u/, and /a/), (2) CVC syllables with the four vowels combined with various consonants (/p/, /b/, /f/, /v/, and /l/) where the initial and final consonant was constant, and (3) four sentences which were loaded with the experimental vowels. The sentences were structured in such a way that there were no nasal consonants. This resulted in the following sentences:

1. She feeds the three geese peas, beets, or wheat.
2. Dad patted the black cat that sat beside the hat.
3. As a rule I play pool with Ruth or Julie who are two cool ladies.
4. Polly Block bought her father's lot.

In addition, each subject read a standard passage, "Lazy Jack", which contains all of the phonemes of the English language in approximately the frequency with which they occur.

### PROCEDURE

**Speech recordings.** Each subject had an opportunity to become familiar with the experimental speech tasks prior to speech recording. Each of the speech tasks was printed on an individual cue card. Subjects were asked to repeat any productions judged by the experimenter not to be phonemically representative of the vowels or consonants on the appropriate cue card.

An Electrovoice 674 microphone and a Revox A-77 tape recorder were used to record the speech tasks. Care was taken to maintain a microphone to mouth distance of approximately twelve inches during all speech productions. The recording gain levels were adjusted for each subject so that the VU meter peaked between zero and one when the subjects counted from one to ten before the recording was made. All subjects performed the experimental tasks in the following order: (a) 'Lazy Jack' task, (b) sustained isolated vowels, (c) CVC syllables and (d) vowel-loaded sentences.

Two master tapes were prepared for experimental task rating; one for connected speech items ('Lazy Jack' task and vowel-loaded sentences), and one for isolated speech items (vowels and CVC syllables). On both master tapes the sample number was recorded before each sample and a five-second interval was allowed for the listeners to judge and record their ratings. Connected speech and isolated speech items were randomized with the restriction that no two samples from the same speaker were adjacent to each other. Connected speech items were prepared for backward play to minimize the influence on nasality judgments by irrelevant factors such as speech proficiency, Sherman, (1954).

**Scaling Procedures.** The psychological scaling method of equal-appearing intervals was used to obtain data for computing measures of nasality, with "1" representing least severe nasality and "7" representing most severe nasality.

The listeners were 21 University of Minnesota speech pathology students. Four of the 21 listeners were also the judges who had rated the 'Lazy Jack' task in forward playback, in order to assign subjects to groups of mild and moderate-severe nasality. This provided some data for comparison of severity of hypernasality on forward versus backward mode. After a practice period to acquaint the judges with the range of severity of nasality, the tape recordings of the connected speech tasks were presented to them with instructions for evaluation. The same procedure was then followed with the tape recordings of the isolated speech tasks.

## RESULTS

**Mean Scale Values.** Mean scale values of severity of nasality for the two groups of cleft palate speakers were derived from the judgments of the 21 listeners on isolated vowels, CVC syllables and vowel-loaded sentences. For the mild group, the overall mean was 2.95; for the moderate-severe group, the mean was 4.25. The mean rating for the two groups by task are shown in Table 1.

PHONETIC CONTEXTS	VOWELS				Means
	/u/	/ae/	/I/	/u/	
<b>Mild Group</b>					
Isolation	1.99	2.04	2.71	2.92	2.42
CVC syllable					
p	2.08	1.95	2.63	2.86	2.38
b	2.97	3.20	3.45	3.44	3.26
f	2.59	3.01	2.96	3.19	2.93
v	3.08	3.10	3.44	3.56	3.29
l	2.99	3.02	3.38	3.43	3.20
Sentences	3.16	3.08	2.99	3.62	3.21
Means	2.69	2.77	3.08	3.28	2.95
<b>Moderate-Severe Group</b>					
Isolation	2.63	3.16	3.57	3.71	3.27
CVC syllable					
p	3.45	3.56	4.30	4.37	3.92
b	4.15	4.37	4.36	4.69	4.51
f	3.89	4.07	4.23	4.53	4.18
v	4.46	4.56	4.40	4.78	4.55
l	4.18	3.99	4.48	4.04	4.17
Sentences	4.78	4.83	5.48	5.43	5.13
Means	3.93	4.07	4.47	4.50	4.25

**Table 1.** Mean ratings of nasality for isolated vowels, CVC syllables and sentences for each of two groups.

**Differences Among Speech Tasks.** An analysis of variance was carried out on the mean ratings for the four vowels in the three main speech tasks, and between the two groups. The results of this analysis are presented in Table 2. It can be seen that statistically significant differences were found between groups (.01 level) and between tasks (.001 level). That is, the moderate-severe group was judged to be significantly more nasal than the mild group, and greater task complexity resulted in increased nasality for both groups.

**TABLE 2** Summary of Analysis of Variance for evaluating differences among vowels, among tasks and between groups, with respect to ratings of nasality.

Source	dfN	dfD	F
Groups (G)	1	12	17.48**
Tasks (T)	2	24	27.97***
Front-Back Vowels (FBV)	1	12	.14
High-Low Vowels (HLV)	1	12	20.38***
G-T	2	24	4.50*
G-FBV	1	12	2.43
T-FBV	2	24	.57
G-HLV	1	12	.28
T-HLV	2	24	1.88
FBV-HLV	1	12	2.51

F .05, .01, .005 & .001 are derived from the tabled values for the nearest given dfs (dfN=degrees of freedom for numerator; dfD=degrees of freedom for denominator).

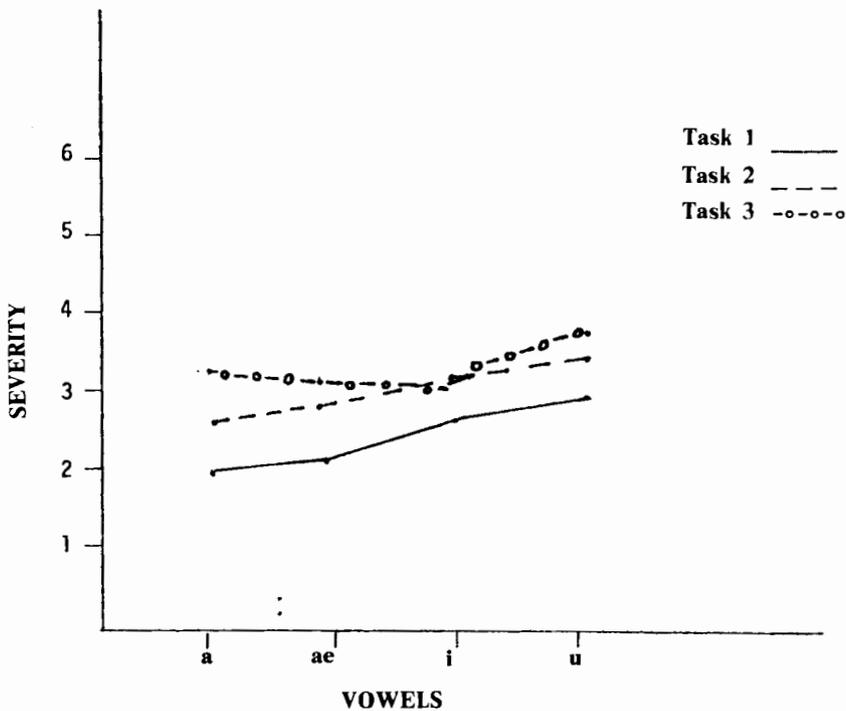
\* .05 level of confidence

\*\* .01 level of confidence

\*\*\* .001 level of confidence

In addition, an interaction effect occurred between the groups and tasks (.05 level). The source of the interaction is represented in Figures 1 and 2. The moderate-severe group showed significantly greater increases than the mild group as a function of task complexity. No overlap is seen in the mean severity distributions for the three tasks for the moderate-severe group (Figure 2). In contrast, for the mild group (Figure 1) only the mean scale values for isolated vowels clearly separate from the mean scale values for the other two tasks.

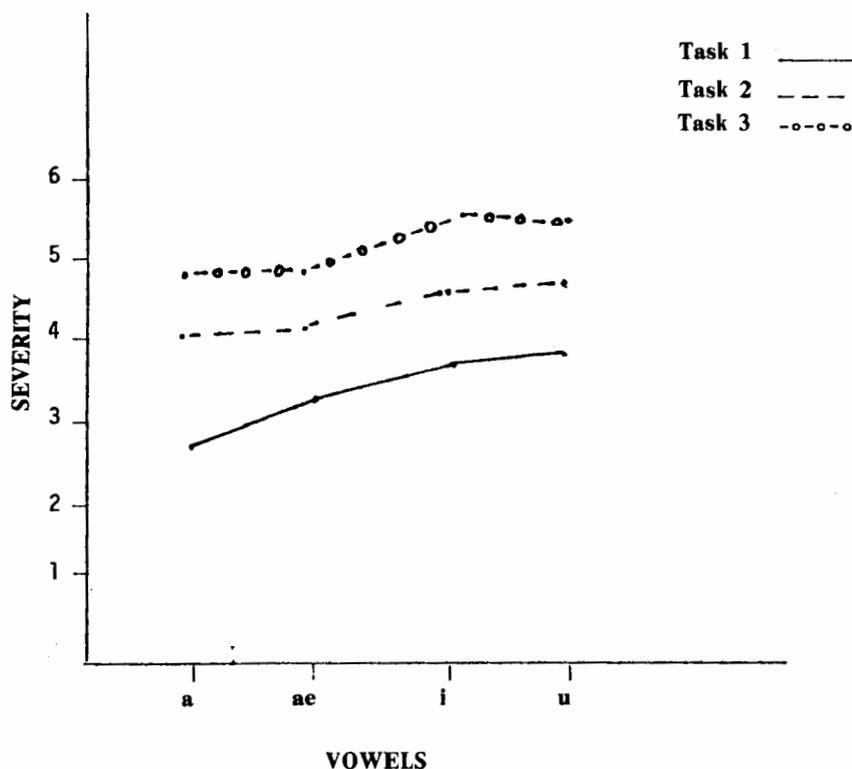
**Figure 1.** Mean ratings of nasality for vowels in Task 1, isolated vowels; Task 2, CVC syllables; and Task 3, sentences; **for the mild group.**



**Differences Among Vowels.** Table 2 indicates that a statistically significant difference (.001 level) occurred between high versus low vowels for all three speech tasks. That is, for both groups of cleft palate speakers, and for all speech tasks, nasality was judged to be more severe, on the average, on the high vowels than on the low vowels.

An analysis of variance (Table 2) failed to reveal any statistically significant differences between front and back vowels for either group, or across speech tasks.

**FIGURE 2** Mean ratings of nasality for vowels in Task 1, isolated vowels; Task 2, CVC syllables; and Task 3, sentences; for the moderate-severe group.



**Differences Among Consonant Contexts.** An analysis of variance was carried out in order to assess differences between the two groups across the factors of voicing and manner of articulation (fricative and plosive). Since the consonant /l/ does not have a voiceless cognate, the manner of the articulation of semi-vowel could not be included in this analysis.

Table 3 reveals that statistically significant differences (.001 level) were found for both groups for the voicing dimension. That is, for both groups of cleft palate speakers, in general, CVC syllables with voiced contexts were judged to be more nasal than those with voiceless contexts.

**TABLE 3** Summary of Analysis of Variance for CVC syllable tasks except semi-vowel tasks for evaluating differences among vowels, consonant contexts, and between groups with respect to ratings of nasality.

Source	dfN	dfD	F
Groups (G)	1	12	19.58***
Plosive-Fricative (PF)	1	12	3.12
Voiced-Voiceless (VV)	1	12	25.04***
Front-Back Vowel (FBV)	1	12	00.00
High-Low Vowel (HLV)	1	12	9.03*
G-PF	1	12	.36
G-VV	1	12	00.38
PF-VV	1	12	5.23*
G-FBV	1	12	00.00
PF-FBV	1	12	.31
VV-FBV	1	12	.24
G-HLV	1	12	00.00
PF-HLV	1	12	6.67*
VV-HLV	1	12	4.28
FBV-HLV	1	12	3.13

F .05, .01 & .001 are derived from the tabled values for the nearest given dfs. (dfN = degrees of freedom for numerator; dfD = degrees of freedom for denominator).

\* .05 level of confidence

\*\* .01 level of confidence

\*\*\* .001 level of confidence

Although statistically significant differences were not found for the plosive versus fricative manner of articulation for either group, a significant interaction occurred between voicing and manner of articulation (.05 level). That is, syllables with the voiceless fricative contexts were perceived as more nasal than the syllables with the voiceless plosive contexts for both groups, although the difference appears small. In contrast, significant differences were not found between voiced fricative and voiced plosive contexts.

An interaction between manner of articulation and vowel height (.05 level) also occurred. While CVC syllables with low vowels and in fricative contexts received more severe nasality ratings than low vowels with plosive contexts, this trend did not apply for CVC syllables with high vowels.

A second analysis of variance in order to evaluate the significance of the manner of articulation of semi-vowel was carried out. No significant differences were found in judgments of nasality for a semi-vowel context in comparison to a fricative or plosive context.

**Differences Between Backward and Forward Modes of Presentation.** A comparison was carried out for the four raters who judged nasality for the reading passage ('Lazy Jack') in the modes of forward and backward play. The mean scale value for the reading task for the mild group in forward play was 2.25, in contrast to the more severe rating of 3.38 in backward play. For the moderate-severe group, the mean scale value in forward play was 5.21 and 5.12 in backward play.

An analysis of variance indicated that mean scale values for all subjects combined, between forward and backward play, differed significantly (.05 level), as represented in Table 4. It was apparent that differences in the mild group alone produced the overall result that, when all subjects are combined, they differed significantly on this variable. In contrast, mean scale values for the moderate-severe group were very similar in both modes of presentation.

**TABLE 4** Summary of Analysis of Variance for 'Lazy Jack' speech task for evaluating differences between forward and backward modes of play and between groups, with respect to ratings of nasality.

Source	dfN	dfD	F
Groups (G)	1	10	23.82***
Forward-Backward (FB)	1	10	8.46*
G-FB	1	10	10.38**

F .01, .05 & .001 are derived from the tabled values for the nearest given dfs. (dfN = degrees of freedom for numerator; dfD = degrees of freedom for denominator)

- \* .05 level of confidence
- \*\* .01 level of confidence
- \*\*\* .001 level of confidence

**Reliability.** In all cases Hoyt's, (1941) reliability was computed by means of a variety of analysis of variance procedures. Interjudge and intrajudge reliabilities were calculated for all experimental tasks. Interjudge reliabilities for the twenty-one raters were as follows: .93 for isolated vowel tasks; .94 for CVC syllable tasks; and .97 for sentence tasks. In contrast, intrajudge reliabilities were as follows: .40 for isolated vowel tasks; .41 for CVC syllable tasks; and .60 for sentence tasks. These results provided evidence for satisfactory interjudge reliability and unsatisfactory intrajudge reliability, with higher reliability for connected speech tasks than isolated vowel and CVC syllable tasks.

Interjudge and intrajudge reliabilities were also computed for the four raters, who judged the 'Lazy Jack' task in the forward and backward modes of presentation. Interjudge reliability for the four raters was .92 in forward play, while it was .80 in backward play. Intrajudge reliabilities were as follows: .73 for forward play and .50 in backward play. These results indicated that nasality judgments are considerably more reliable when connected speech is presented in forward play rather than backward play.

### DISCUSSION

Within the limitations of this study, the results indicate that severity of nasality, in general, increases progressively from vowels in isolation, to CVC syllable, to vowel-loaded sentences for cleft palate individuals judged to have mild or moderate-severe hypernasality. However, increases in nasality with increased task complexity were significantly greater for the moderate-severe group than for the mild nasality group. A search of the literature has not indicated that other investigators have compared two subgroups of cleft palate speakers with respect to severity differences.

From these results, it appears that the use of nasality ratings based on isolated vowels and CVC syllables for predicting the relative amount of nasality in connected speech may be a more appropriate procedure for cleft palate speakers with mild hypernasality than for speakers with moderate-severe hypernasality.

Previous research findings indicating that degree of perceived nasality of cleft palate speakers is less severe on low vowels than on high vowels were confirmed in the present investigation (Spriestersbach and Powers, 1959; Carney and Sherman, 1971; and Moore and Sommers, 1973). For both groups this trend was found for vowels in isolation, CVC syllables, and vowel-loaded sentences. However, contrary to the findings reported by others that the degree of perceived nasality of cleft palate speakers is greater on front vowels than on back vowels, no significant difference was found for this variable in this study.

The finding that characteristics of vowels vary systematically with the type of consonant context is in agreement with the findings of previous researchers Moore and Sommers, (1973); and Lintz and Sherman, (1961). The effects of voicing were greater than those of manner of articulation with less severe nasality for syllables with voiceless than voiced contexts. Though manner of articulation by itself did not appear to be a significant variable, less severe nasality was perceived with plosive than fricative contexts, when the syllables had voiceless consonant contexts and/or low vowels contexts. Voicing and tongue height appeared to have a greater influence on perceived nasality than did manner of articulation.

The finding that vowels with different manners of articulation are not judged to be significantly different in terms of judged nasality is contrary to the results reported by another investigator who studied cleft palate speakers (Moore and Sommers, 1973). The

disagreement can be explained perhaps by differences in subject selection criteria and speech tasks.

In the present investigation, subjects were chosen who could articulate correctly all the CVC syllable tasks. The consonant contexts /s/ and /z/ were not included due to the frequency of articulatory errors on these phonemes (Van Denmark and Van Denmark, 1967), and the relative inconsistency in the articulation of /s/ by cleft palate individuals (McDermott, 1962). In contrast Moore and Sommers (1973) did not attempt to select particular cleft palate individuals or speech tasks, so that articulation would be correct. Though they found that semi-vowel, plosive, and fricative contexts were judged to be significantly different in terms of perceived nasality severity, their results may have been related to the possibility that their cleft palate subjects did not articulate the consonants correctly. The results might have been relevant to entirely different consonant contexts than those intended.

The results of this study revealed divergent findings for the mild and moderate-severe nasality groups for backward versus forward mode of speech presentation. When heard in the forward mode, the listeners tended to rate the mild group as having relatively little nasality. Conversely, when the same listeners rated the same speakers in a similar speech task presented in the backward mode, most of the scores tended to cluster in higher ratings. In contrast, the mode of play did not appear to play an important role for the moderate-severe group. Furthermore, for both groups of cleft palate speakers, reliability was higher for connected speech presented in forward play. These data support Fletcher and Bishop's (1970) conclusion that backward playing introduces its own set of contaminants. On the basis of the results of this study, this appears more crucial for speakers with mild hypernasality.

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