

THE ROLE OF PHONETIC CONTEXT IN THE ARTICULATION OF SEMIVOWELS BY PRESCHOOL CHILDREN

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active environment, affect the consonants' production.

Introduction

One of the most important tasks children face during preschool years is learning how to speak intelligibly. Children's early speech is characterized by a number of differences from that of adults, such as various types of phoneme, and in particular consonant, misarticulations including omissions, substitutions, and distortions. Therefore, "it might be imagined that if there were any major issue in child phonology for which study of consonants alone was sufficient it would be that of how correct consonant production is acquired. In fact, the typical focus on consonant acquisition independent of vowel acquisition involves the tacit assumption that consonants are context independent" (Davis & MacNeilage, 1990, p 16). The phonetic context which involves a certain degree of coarticulation can facilitate or even interfere with correct production of the phonetic segment. Coarticulatory influences can be due to the anticipatory effect of an upcoming phonetic segment or to inertial carry-over effect of a preceding segment. Recasens (1989) demonstrated that anticipatory coarticulations reflect phonemic preprogramming while carry-over effects are mainly due to articulatory constraints. Therefore, the effect of phonetic context could explain why misarticulations are often inconsistent.

One of more frequent children's misarticulations is a gliding of prevocalic liquid. Some aspects of /r/ misarticulations due to coarticulation can be understood by knowing the extent to which individual phonemic segments restrict the position of the various articulators. The /r/ productions are characterized by the tongue tip pointed upward and slightly backward in the mouth cavity, or by bunching of the tongue in the center or near the front of the mouth cavity. Therefore, the production of the phoneme /r/ is very demanding on articulators, as the palatal /r/ strongly restricts the blade, dorsum and body of the tongue. The glide /w/, which is close to the phoneme replacing /r/ during misarticulations, is characterized by a gradual move from a rounded and narrowed configuration to the lip shape required by the following vowel, simultaneously with a change in tongue position from high-back to the position for the following vowel. Thus it seems a plausible assumption that the vocalic quality of consonants' neighbors, which constitute the totality of their

The present study addresses the following questions about children's production of the phoneme /r/: 1) How are misarticulated phonemes different from those that are correctly produced? 2) Does the phonetic context of the following vowel influence phoneme production?

Method

1. Subjects.

The subject population consisted of two groups of 5 preschool children with normally developing articulation skills, ranging in age from 3 years 3 months to 4 years 2 months. The children were monolingual speakers of English, and had no history of speech or language difficulties. The first (control) group consisted of children with a mean age of 3 years 7 months, highly intelligible speech and no misarticulation. The second (misarticulated) group consisted of children with a mean age 3 years 9 months, was also characterized by highly intelligible speech, with the exception of /r/ misarticulations.

2. Stimuli.

A set of four objects or pictures corresponding to words beginning with the /r/ phoneme and followed by four different vowel environments (/i/, /e/, /ae/, and /a/) were chosen as stimuli (e.g. rock, rabbit, read).

3. Procedure.

The procedure for collecting the pertinent data was divided into two steps: 1) gathering samples of speech; 2) analyzing speech to determine the nature of physical differences between samples of the /r/ phonemic segment and its misarticulations. A set of 4 objects or pictures representing the stimuli words were placed in front of the seated child. The children were then asked to name these. Five tokens of each of the words with /r/ in the initial position followed by vowels /i/, /e/, /ae/, and /a/ were collected in a random manner and recorded.

4. Acoustical analysis.

Tokens were digitized using a MAC II computer with 20kHz sampling rate, 12-bit quantization and a 9.6-kHz low-pass filter. The samples were classified as being an /r/ or a misarticulated /r/. Spectrograms of these samples were analyzed in the frequency and time domains, 25 ms Hamming window, frequency range from 0 Hz to 10 kHz, and high-frequency shaping. Using criteria discussed by Chaney (1988), the transition onset point of the consonant was

defined as the starting point of directional shift in the F2 transition. Transition termination was defined as the point where transition reached the vowel steady state. At such determined points spectra were analyzed, and frequencies of onsets and offsets of the F2 transition were measured. A similar method was applied to determine the onset and offset of F3 transitions.

Results

The analyses of the /r/ productions showed that the percentage of misarticulation for the entire subject population was dependent on the context of the following vowel. When /r/ was followed by a front vowel, the misarticulation percentage was 32.6%. This error rate increased to 40% when the vowel was produced in the back of the vocal cavity. Moreover, differences in the number of misarticulations were found among /r/ articulations followed by the front vowels. The highest error rate of 37% was associated with the low vowel /ae/, followed by 32% (high vowel /i/), and 28% (middle vowel /e/).

Acoustic analyses showed strong lingual coarticulatory effects for /r/ articulated subjects and no such effect for /r/ misarticulated subjects. For the /r/ articulated group, significantly different onset frequencies of the F3 transition were found in four vocalic environments ($F(3,44)=3.38$ $p<.05$). This result was due mainly to the higher onset frequency of the F3 transition (2222 Hz) in the environment of the back vowel /a/, as compared to lower onset frequencies in the vocalic environment of front vowels (/ae/-2174 Hz; /i/-1954 Hz; and /e/-1949 Hz). The differences between onset frequencies of F3 and F2 transitions (cue for /r/ recognition) were context dependent ($F(3,44)=5.053$ $p<.5$). (/ae/-991 Hz; /i/-705 Hz; /e/-654 Hz; and /a/-968 Hz). However, the /r/ articulated children did not show differences in F2 transition duration, which was on average (for the four vocalic contexts) equal to 65 msec. Moreover, onset frequencies of the F2 transition did not differ significantly in the four vowels contexts, and could be described by a mean of 1245 Hz. The group of misarticulated children did not demonstrate significant differences dependent on phonemic context on any of the above described measures. However, differences between onset frequencies of F3 and F2 transitions varied depending on the following context. The mean differences were equal to 2009 Hz, 2086 Hz, 2356 Hz, and 2542 Hz for /ae/, /i/, /e/, and /a/ vocalic contexts respectively. Thus, the /r/ misarticulated phonetic segment was produced in a similar manner in all examined phonetic contexts, with mean for transition duration (average for four vowel context conditions)

of 57 msec, and a mean onset frequencies for F2 and F3 transitions of 1201 Hz and 3449 Hz respectively. Furthermore, the statistical analysis showed significant differences in the onset frequencies of the F3 transitions between the /r/ and its misarticulations in all four vocalic contexts. The perceptual test, which examined discrimination of ten minimal-pair r/w approximant consonant contrasts demonstrated that the /r/-articulated group scored on average 96% on perceptual task while misarticulated group scored on average 82%.

Summary and discussion

The results of the present study indicate that r/w substitutions in CV syllable do not occur in an unpredictable manner, but instead are influenced by the vowel context. When /r/ is followed by a phoneme articulated at the front of the mouth cavity, the error percentage of misarticulation is significantly smaller than when the /r/ is followed by a phoneme articulated at the back of the mouth cavity. Misarticulations occur in conditions that require a significant change in the configuration of articulators. The acoustic analyses support Chaney's study (1988), that strong lingual coarticulatory effects depending on the following vowel are present for the /r/ phonetic segment, but they are absent for the /r/-misarticulations. Thus, the /r/ articulating children's consonant-vowel coarticulation must be due to the greater overlap between their consonant and vowel lingual gestures, that is, e.g., to greater fronting of the tongue body before /i/ and greater backing of the tongue body before /a/. These results are indicative of better controlled processes of the phonemic preprogramming among children articulating the /r/, compared to the /r/-misarticulated children. This study's findings that the /r/-misarticulated children scored lower on the phonemic contrast perceptual task compared to the /r/-articulated children, supports the point of view that the perception of phonemic contrast precedes its production.

Bibliography

- Chaney, C. (1988). Acoustic analysis of correct and misarticulated semivowels. *Journal of Speech and Hearing Research*, 31, 275-287.
- Davis, B.L., & MacNeilage, P.F. (1990). Acquisition of correct vowel production: A quantitative case study. *Journal of Speech and Hearing Research*, 33, p.16.
- Recasens, D. (1989). Coarticulatory mechanisms for tongue-dorsum activity in running speech. *Journal of Acoustical Society of America*, Suppl.1, 85, S148.