/r/ MISARTICULATION IN CHILDREN'S SPEECH

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ABSTRACT - The speech productions of children who were identified as producing /w/ for /r/ substitutions were subjected to spectrographic analysis in an attempt to validate the assumption that such children do not contrast between /r/ and /w/ phonemes in their speech. Analysis revealed that the misarticulating children actually produced similar acoustic distinctions between their /w/ and intended /r/ as did a matched control group. Any differences were of degree rather than type. The presence of acoustic contrasts suggest that the classification of errors as substitutions may be incorrect but can probably be attributed to the language specific phonological biases which constrain the perceptions of listeners.

INTRODUCTION

When speech pathologists classify articulation errors they often use a three way categorisation system which labels errors as omissions, substitutions, and distortions (Bankson and Bernthal, 1982). Recently, there has been some discussion as to whether this system can be reliably used to describe the phonological implications of phonetic events.

The term substitution, for instance, carries with it the assumption that the speaker replaces the predicted phonetic realisation of a target phoneme with another from the segmental inventory of the language thus effectively neutralising an important phonemic distinction. A simple example is the substitutuion of /w/ for /r/ in /rəbət/ yielding /wəbət/. When we attempt to classify errors in this way we are inevitably constrained by the phonologically motivated perceptual biases of our native language. There is abundant evidence in the speech perception literature to indicate that listeners are most sensitive to phonetic differences which determine phonological distinctions and least sensitive to those which do not (Liberman, Harris, Hoffman, and Griffith, 1957). Thus if a speaker produces phonological contrasts which fall within the acoustic space occupied by a single phoneme for a particular listener then such contrasts may not be perceived and only a single phoneme identified. The speaker and the listener may be operating in two differing phonological systems.

The present study was conducted to test whether such a phenomenon may occur when adults listen to child talkers. Our aim was to determine whether children who were perceived to substitute one sound for another were actually neutralising an important phonemic contrast or whether adult listeners were possibly operating under a different system and thus not attending to contrasts present in the children's speech.

METHOD

Twelve boys with a mean age of 6.47 years who were consistently identified as producing /w/ for /r/ substitutions but no other articulation errors made up the experimental group. A further twelve boys with a mean age of 6.46 years who exhibited no articulation errors made up the control group. Both groups were screened for articulation and hearing.

The children were recorded producing ten minimal pairs which differed in the initial consonant /r/ or /w/. The words were elicited by presenting each child with a picture on a card for identification and utilising appropriate cueing strategies where necessary. The test items were as follows: "wing, ring, roar, war, whale, rail, reel, wheel, one, run, wide, ride, weed, read, white, write, red, wedding, witch, rich".

The test words were analysed spectrographically and the following information extracted (see figure 1): F1, F2, F3 at the beginning of the consonant (a), at the beginning of the transition (b), at the beginning of the vowel steady state (c), at the vowel target (d), as well as the duration of the consonant steady state (t1), the transition (t2), the vowel steady state (t3), and the total syllable (T).

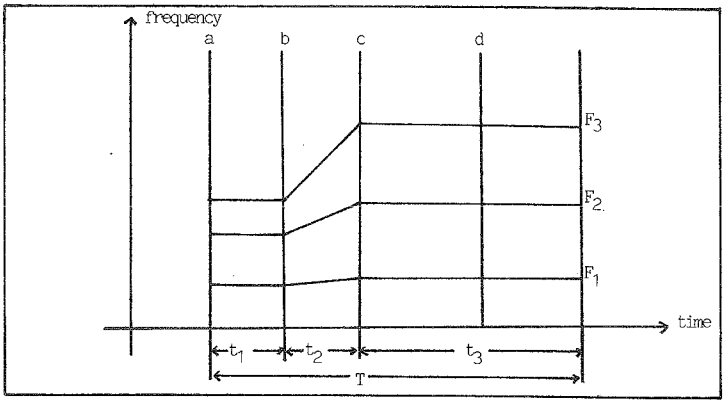

Figure 1. Acoustic structure of CV syllable approximants.

For each word at each point the groups' values were analysed to give descriptive statistics. Two sample t tests were used to determine whether there were any significant differences between the means for the experimental and control groups for individual words and also to determine whether there were any significant differences within the groups between pairs of minimally contrastive words.

RESULTS

Formants one, two and three at the onset of the consonant and the onset of the transition proved the most informative of all frequency data.

For /w/ - F1 did not vary significantly between the control and the experimental group.
- F2 was often higher for the control group than the experimental group but this was generally not significant.
- F3 was generally lower for the control group than the experimental group but this again was not a significant difference.

For /r/ - F1 was not significantly different between the groups.
- F2 was always higher in the control group but this difference was only significant in 55% of cases.
- F3 was consistently significantly higher for the experimental group.

For both groups combined

- F1 of /w/ was usually lower than F1 of /r/ however this was not generally significant.
- F2 of /w/ was always lower than F2 of /r/ and this reached significance in all but one minimal pair.
- F3 of /w/ was always higher than F3 of /r/ however this difference was only significant for the control group.

Consonant to Vowel Formant Trajectories

The approximant consonants are characterised by movements of their formants and so we attempted to capture this movement by representing the first three formants in a two dimensional plane. Formant trajectory diagrams were constructed which depicted the movement of the formants from the transition onset to the vowel target onset. The resulting line of trajectory represents the formant movement. Figure 2 is the consonant to vowel formant trajectory diagram for the minimal pair /wid/ /rid/.

Elipses have been drawn around the single transition points to represent the range within which there is a 95% chance that the true mean of the population will occur.

The trajectory diagrams illustrate that for the control group /r/ and /w/ are always clearly separated from each other in both the F2/F3 plane as well as the F2/F1 plane. The experimental group also exhibited separated /r/ and /w/ in most cases. (In only 20% of cases there was some slight overlap.)

The experimental group's /r/ and /w/ regions were generally closer together than those of the control group. The /w/ regions for both the control and experimental groups generally tend to overlap quite considerably. It does seem however that because the experimental /r/ is also very close to control /w/ the experimental group has produced a /w/ which has been shifted in a direction away from their /r/ area. This creates more distance between their /r/ and /w/ and can be seen quite clearly in Figure 2.

Distribution of Energy in the Spectrum

The frequency difference between F2 and F3 at the onset of the consonant steady state also provided interesting results. This gives an indication of the distribution of energy in the spectrum. For /r/ there should be a

smaller difference between F2 and F3 than for /w/ because the two formants are closer together. Thus a significant difference between the /r/ F2 to F3 distance and the /w/ F2 to F3 distance could provide a cue for consonant differentiation. Figure 3 illustrates the differences between the control and the experimental groups.

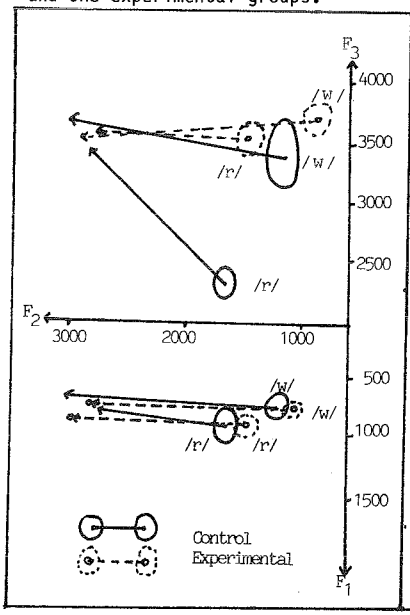

Figure 2. Formant trajectories from the onset of the transition to the onset of the vowel target for /wid/ and /rid/.

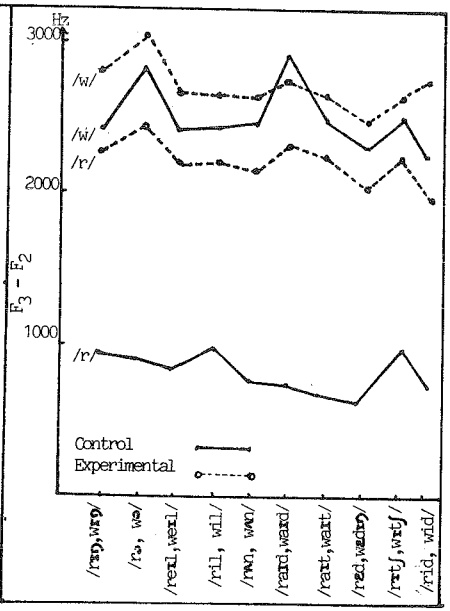

Figure 3. The frequency distance between F2 and F3 at the onset of the consonant steady state for /r/ and /w/.

It can be seen that for the control group the distance between F3 and F2 for /r/ was always very much smaller than the distance between F3 and F2 for /w/ and t tests showed that this difference was highly significant. For the experimental group the distance between F2 and F3 for /r/ was significantly different to the /w/ F2 F3 difference in all but two cases.

Transition Rates

The rates of consonant to vowel transitions also provided some interesting results which could not be directly identified from the transition duration data alone.

Figure 4 shows that there is a very close correspondence between the control and the experimental groups for the transition rate of F1. There were no significant differences between the groups except in one case.

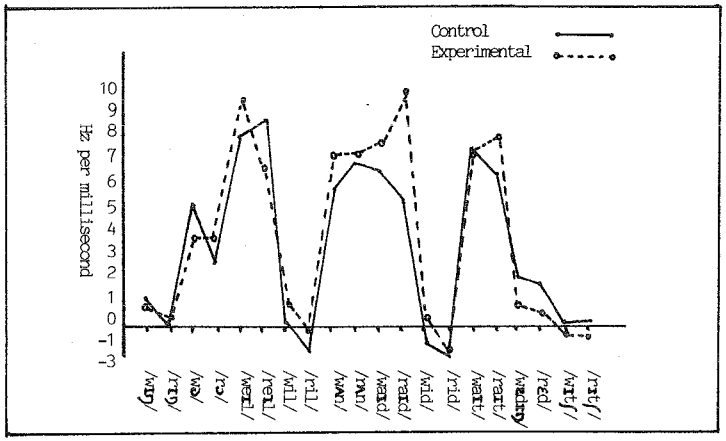

Figure 4. The rate of transition of Formant 1 for each individual word.

Figure 5 again shows a very close correspondence in the rate, this time of F2, and again there were generally no significant differences.

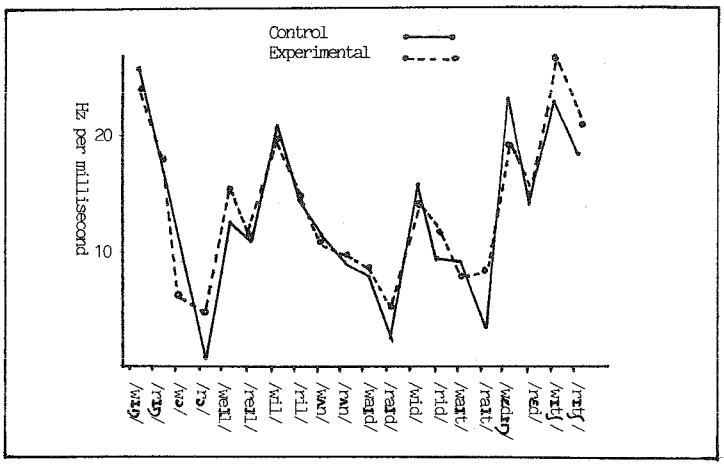

Figure 5. The rate of transition of Formant 2 for individual words.

Figure 6 illustrates that the two groups differ markedly on F3 for /r/ but not for /w/. The experimental group's /r/ production has a similar transition rate to their /w/ production and differences only reach significance in one case.

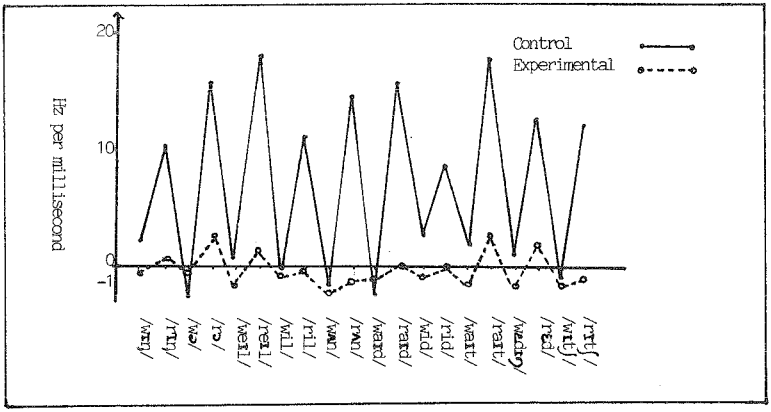

Figure 6. The transition rate of Formant 3 for each word.

DISCUSSION & CONCLUSIONS

The results of the present study show

- the cues available to the non-misarticulating child in differentiating between /r/ and /w/ in their speech.
- that misarticulating children make use of many of the same cues as the non-misarticulating child.
- that the experimental group children maintain and maximise F1 and F2 information in differentiating between /r/ and /w/ however their F3 cues are not entirely satisfactory.
- that the experimental group children attempt to maximise phonetic contrasts by moving their /w/ so that there is maximal acoustic distance between the two phonemes.
- that children were not producing a direct phoneme substitution as this would have resulted in acoustically nondistinct homophonous items in each minimal pair.

We can conclude from these results that minimally contrastive items which were perceived by adult listeners as homophonous were consistently phonetically distinct. This calls into question the validity of imposing the perceptual biases of ones native phonology onto the speech productions of those who may be operating under differing phonological constraints in a differing phonological system.

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