1974

# A Durational Analysis of Inter-Syllabic and Intra-Syllabic /r/ Blends

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# A DURATIONAL ANALYSIS OF INTER-SYLLABIC AND INTRA-SYLLABIC /r/ BLENDS

(TITLE)

BY

JERRY E. WASSON

**THESIS**

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1974
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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ACKNOWLEDGEMENTS

The completion of this thesis is due to the combined efforts of many. Appreciation is extended to Dr. Lynn Miner for his patience and guidance throughout this research endeavor; to Dr. Jerry Griffith for his "rational beliefs"; and to Dr. Wayne Thurman for encouraging me to enter this profession.

Charlotte, you have given me the strength to continue. Thank you for your patience.

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# CHAPTER I

## INTRODUCTION

Speech pathologists in the public schools have often noted that the greatest portion of their case load is involved with functional articulation disorders. Powers (1971) estimated that between 75 and 80 per cent of the speech defectives in the school population are those classified as functional articulation disorders. Consistent with Power's estimate, Van Riper (1972) reports that over 75 per cent of all speech problems are articulatory in nature. With such a population occupying such a large portion of the speech clinician's case load, the need for accurate and efficient measurement tools is obvious. Each clinician is faced with the dilemma, "What test should I use?" Presently the answer to this question lies at least in part in one's own bias.

A dichotomy is formed by two camps of thought concerning articulation testing: word (static) vs. running speech (dynamic) tests. In the past, the justification for testing speech at the word level appeared to be based on the premise that the continuous flow of speech could be broken down into integral units which would be representative samples of

continuous speech. Many researchers, including Cooper (1950); Curtis (1951); Stevens and House (1963); Stevens, House and Paul (1966); Ohman (1966); Shohara (1939); and Stetson (1951), have provided evidence which indicates that speech sounds cannot be viewed as separate and independent entities when they occur in the presence of other speech sounds. Thus, it appears that there is considerable coarticulation between phones; that is, articulatory characteristics that are involved in the production of one phone may be observed during the same time segments assigned to other phones in the sequence. Coarticulation appears to be conditioned by various prosodic features, including stress, rate of utterance, phonetic context and morphemic boundaries (Lindblom, 1963; Stevens and House, 1963; Lehiste, 1962; and Ohman, 1966).

The case for the dynamic assessment of an individual's articulatory ability is strengthening as can be seen by examination of the literature. Cooper (1950), in viewing some of the potential uses for the sonograph, stated that "it is in the capacity to deal with the dynamics of speech that the major virtue of the equipment lies." As Cooper discusses the merits of the spectrum analysis he indicates that the importance of such analysis lies in the resulting spectogram. The "picture" supplements the auditory channel and thus offers researchers a means for cross comparisons of two separate sensory modalities.

The overwhelming evidence supporting the case for coarticulation and controlling for phonetic context has created new and challenging questions to be answered by individuals constructing articulation tests. One such important question involves the testing of blends. Is testing for inter-syllabic blends equivalent to testing for intra-syllabic blends? McDonald (1964) has stated that "the articulatory movements for producing one type of context might be sufficiently similar to those required for producing another context that only one of them need be evaluated" (underscore added). How then does one account for the difference he "knows" he hears between the combinations "cup/ray" and "cup/pray"? This intuitive evaluation that there is a perceptual difference between the inter-syllabic and intra-syllabic blends has enough clinical significance to warrant analysis.

The purpose of the present investigation was to evaluate the equivalence of compound consonant sequences and abutting consonant blend sequences for deep testing articulatory ability for the /pr/, /tr/, /gr/ and /br/ blends.

At the onset of this investigation the following questions were posed:

1. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /pr/ blends?

2. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /tr/ blends?

3. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /gr/ blends?

4. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /br/ blends?

# CHAPTER II

## REVIEW OF THE LITERATURE

A comprehensive review of the literature was necessary to determine the extent and nature of previous research dealing with the various parameters of blend analysis and the implications of that research upon the present investigation. Such a review follows.

Schuckers (1969) points out that the amount of research dealing specifically with the study of consonants is inversely proportionate to their frequency of occurrence in the English language. The consonants perform more work in less time, consuming less energy than their partner, the vowel. The field of acoustic phonetics is relatively young and most of the measuring instruments have been invented since 1920. The vowels are easier to study. The consonants, due to their complex noise make-up, short duration and larger numbers, were not studied until the 1960's. The blends, a subgroup of the family of consonants, lack little recognition in the literature yet today.

Concerning the evaluation of the consonant, Curtis (1951) recognized the need for evaluating running speech. He stated that word testing is "not representative" of an individual's

true articulation ability. He further noted that the overlapping movements of articulation produce "important and significant" modifications in the acoustical nature of speech and calls attention to the "transitional variations" (in the acoustic spectrum of a sound) resulting from the interactions of consecutive sounds.

More recently, Stevens and House (1963); Stevens, House and Paul (1966); and Ohman (1966) have demonstrated coarticulation for consonant-vowel-consonant (CVC) and vowel-consonant-vowel (VCV) syllables in which vowels and consonants mutually influence each other in forward and backward directions over as many as two phonemes. Ohman (1967), Lubker (1967) and MacNeilage and DeClark (1967) have presented electromygraphic data which suggest extensive coarticulation of speech gestures dependent upon phonemic environment in both forward and backward direction. Fujimura (1961) and Lindblom (1968), through use of high speed motion pictures, have found extensive vowel-consonant coarticulation of lip and jaw configuration in the forward position.

Because of these effects of coarticulation and phonetic contexts which have been briefly summarized in this review of the literature one may readily recognize the need for dynamic articulation testing.

One cannot consider dynamic articulation testing without examining the syllable, the basic building block of speech.

Shohara (1939) observed that when a group of movements typical of an isolated consonant is combined with another consonant or vowel, the result is not the sum of the two movements, but a new group, and consequently a new sound. Harris (1953) likewise cautioned that speech sounds cannot be viewed as separate and independent entities when they are mutually dependent, as in the syllable, in some very important respects. Stetson (1951) further demonstrated that the syllable should be considered the basic phonetic unit in speech when he pointed out that the syllable is a single ballistic movement; it is impossible to have two stresses within one syllable. According to Stetson, the vowel is the core of every syllable. The consonant releases or arrests the vowel. Through the definitions of the syllable boundaries and of the consonant's role with the syllable, only two testing positions are created: initial (pre-vocalic) and final (post-vocalic), thus forcing re-examination of existing articulation tests which incorporate initial, medial and final testing positions.

Stetson (1951) also found that every syllable exists on a separate chest pulse (pressure); the pressure falls or decreases between the syllable pulses, thus establishing boundaries for individual syllables. Consistent with Stetson's findings, Shohara (1939) has found that the same consonant at different times is produced by different muscle movements

depending on the phonetic context in which it occurs. In other words, a syllable varies according to its phonetic context and cannot be perceived by an analysis of its separate parts. Stetson specifically states that the "pattern context" of speech could not be perceived if its destinguishing items were somehow presented alone.

A more recent report (Cole, 1973)supports the contention that a syllable provides the basic structural unit for grouping phonemes during speech. That is, phonemes are organized in the nervous system in terms of temporal groupings which we perceive as syllables. As we perceive these syllables which the nervous system has neatly organized the term "medial" becomes significant, especially in the evaluation of articulation competency. Keenan (1961) defined the medial position as follows: "A phoneme is in a medial position in a word when it is neither the first nor the last sound in that word" (Keenan, 1961, p. 172). He seemingly felt that the misleading labels of "initial, medial and final" can be replaced with a classification system based upon the consonants relationship to its syllable.

In summary, then, the integrity of the syllable as the basic unit for consideration in the testing of articulation is well founded in the literature, as indicated by the above studies.

As was previously mentioned, approximately 75 to 80 per cent of a speech pathologist's case load in the public schools is involved with functional articulation errors. Of these, approximately 80 per cent involve the /r/, /s/, /l/ or /θ/ phonemes (Southwest Regional Laboratory for Educational Research and Development, 1973). Roe and Milisen (1942) found that the proportion of children making errors on the blends /sk/, /str/ and /dr/ was less than the proportion of children making errors on the single sound elements contained in them. In view of these findings the need for accurate assessment of blend function is apparent. The present investigator feels that the present articulation tests do not represent the acoustical or perceptual qualities of blend combinations as they occur in dynamic speech.

Nelson (1945) was the first to describe the effects of combining sounds of articulation. Spreistersbach and Curtis (1951) later expanded this concept and McDonald (1964) finally systemized it into what he considered to be a clinically useful form: the McDonald Screening Deep Test of Articulation.

Peterson (1972) has expressed doubts about the merits of McDonald's deep test of articulation. He points out that research has confirmed the notion that an experienced speech clinician can attend to the production of more than one sound production, as in the bisyllabic utterances. Interestingly, McDonald criticizes the use of "initial, medial and final"

concepts of articulation testing as being unrepresentative of the normal speaking situation, yet he has 16 initial and 15 final positions in the 90 tested items.

McDonald (1964) developed a pre- and post-vocalic testing procedure for his deep test of articulation. He tested the blend /pr/, for example, by combining the two words "cup" and "rake". The resulting compound noun "cup/rake" is composed of two syllables. Stetson (1951), it may be remembered, reported that the syllable is a single ballistic movement; it is impossible to have two stresses within one syllable. However, McDonald hypothetically tests /pr/ as within one syllable. Thomas (1958) indicated that in a compound noun the stress normally falls on the first element of the compound. Thus, the stress and syllable division for "cup/rake" would be "cup'/rake". On this basis, McDonald has attempted to test one syllable unit with two different stress environments. He has obviously crossed the syllable boundaries (as opposed to testing a phoneme within its syllable).

McDonald (1964), in discussing the requirements of an adequate test of articulation, made two assumptions as a basis for reducing the large number of phonetic contexts to be observed:

> 1. The articulatory movements required for producing one type of context <u>might be sufficiently similar</u> to those required for producing another context that only one of them need be evaluated (underscore added).

> 2. Since vowels are produced by relatively similar articulatory movements, it might not be necessary to study the influence of each vowel on the sound being evaluated (McDonald, 1964, p. 119).

He conceded that intra-syllabic adjacent consonants are not articulated in exactly the same way as when they abut inter-syllabically. Dininny (1963) found that children who misarticulated the /s/ in the inter-syllabic context also did so in the paired intra-syllabic context, and those who correctly articulated the /s/ in the inter-syllabic context also articulated it correctly in the paired intra-syllabic context. In McDonald's view, this finding would lend support to the point of view that it would not be necessary to test a sound both as it occurred in a compound consonant and as a member of an abutting pair. However, the justification for using the abutting contexts is based on the fact that the variety of abutting contexts far exceeds the variety of intra-syllabic blends. In his attempt to decrease the staggeringly large number of possible phonetic contexts present in the English language for an articulation test, he has unjustifiably assumed that the articulatory movements employed in producing one type of context might be sufficiently similar to those required for producing another context. This investigator believes that the articulatory movements required for producing the /pr/, /tr/, /gr/ and /br/ contexts in inter-syllabic combinations are not sufficiently similar to those required for producing the same blends in intra-syllabic combinations.

McDonald's presentation of blends is important since an interesting inconsistency is shown in that the proportion of children making errors on the blends /sk/, /str/ and /dr/ was found by Roe and Milisen (1942) to be less than the proportion of children making errors on the single sound elements contained in them. This may indicate that contrary to the common belief, some sounds are more easily made in blends that are preceded or followed by vowels. The accurate assessment of blends assumes even more significance in light of these above findings.

Regarding McDonald's second assumption, McDonald concluded that since the articulatory movements employed in producing the different vowels are relatively simple in comparison with the more complex movements required for production of most consonants, it might not be necessary to study the articulation of a consonant as it is influenced by each vowel (McDonald, 1964, p. 119). In contrast, however, McDonald (1964, p. 54) has indicated some requirements for a deep test of articulation: "...need exists for a rather detailed testing of any defective sound in all contexts in which it normally occurs for the subject being tested...." Once again, there appears to be a major disjuncture within one of the major articulation testing devices utilized today.

As already mentioned, Roe and Milisen (1942) reported that the proportion of children making errors on certain

consonant clusters was smaller than the proportion of children making errors on the single sound elements contained in the clusters. Spriestersbach and Curtis (1951) in a summary of several unpublished studies by Nelson (45), Hale (48) and Buck (48) concluded among other things that children tend to produce consonant clusters correctly more frequently than they do singles and the "inconsistencies are to be accounted for on a lawful basis (p. 489).

Harisinghani (1973), in a spectrographic analysis of 240 sonograms containing the blends /st/, /str/, /sk/ and /sp/ found that there were not statistically significant differences in duration between the components of the /s/ blends as they occurred in inter-syllabic and intra-syllabic contexts. He concluded that the perceptual differences do not manifest themselves in durational differences.

Taking a slightly different approach, Klatt (1974) analyzed the duration of the /s/ in English words. He found that the duration of /s/ is shorter in multisyllabic words and in consonant cluster sequences. He reported that the most striking example of a cluster-induced durational change is the situation in which /s/ is followed by a stop. Klatt found that the /s/ duration is shorter in this case than for any other phonetic environment.

The implications for continued research in the area of durational analysis of speech sound in specific phonetic

environments are apparent. Whether the results of Harisinghani's study for /s/ blends would be valid for other blends as well remained an unanswered but empirical question until the time of the present investigation.

# CHAPTER III

# PROCEDURE

## Selection of Subjects

Only children with no functional articulation disorders were included in this study. The following children were excluded: those with severe organic impairments, such as cleft palate or cerebral palsy; those who stutter; those with additional speech impairments such as voice disorders or a serious delay in language development. So as to include only children with normal intelligence, those in Educable Mentally Handicapped or exceptional ability classes were excluded. It was hypothesized that exclusion of these children would result in a population of public school children with "average" intelligence. All children were judged as having no observable hearing impairment by the speech clinician and the classroom teacher. Only children from monolingual homes were accepted as subjects for the present investigation.

The subjects were chosen from the third grade in public schools included in the East Central Illinois Speech and Hearing Association. The children were selected by the classroom teacher at each school by utilizing the

previously mentioned criteria. Each subject was administered the Griffith-Miner Phonetic Context Inventory (Griffith and Miner, 1973) for the /r/ phoneme. Any potential subject for the investigation who had one or more errors on the test was excluded from the experiment. The number of subjects (N) was set at twenty (20). Male and female populations were equally divided. The age range of the subjects was from 8.2 years to 9.1 years. Each child was seen individually for both the training and testing portions of the investigation.

Selection of Stimulus Material

The stimulus words used in the present investigation were taken from the first 2,500 most-frequently-occurring-words list. The four most frequently occurring /r/ blend combinations in rank order are: /pr/, /tr/, /gr/ and /br/. The McDonald Picture Test of Articulation tests these blends in inter-syllabic combinations in the following words: "cup/rake," "kite/rake," "pig/rake," and "tub/rake." The four initial words selected for use in the present investigation are consistent with McDonald: "cup," "kite," "pig," and "tub." The secondary words are consistent with the word "rake" in the phonetic context of the consonant-vowel (CV) combination. Specifically, the secondary words used in the experiment are "ray," "rain," "ray," and "rake." A list of each set of stimulus words follows:

| | | |
|---|---|---|
| Set # 1: | cup ray | (inter-syllabic) |
| | cup pray | (intra-syllabic) |
| | pray | (intra-syllabic) |
| Set # 2: | kite rain | (inter-syllabic) |
| | kite train | (intra-syllabic) |
| | train | (intra-syllabic) |
| Set # 3: | pig ray | (inter-syllabic) |
| | pig gray | (intra-syllabic) |
| | gray | (intra-syllabic) |
| Set # 4: | tub rake | (inter-syllabic) |
| | tub brake | (intra-syllabic) |
| | brake | (intra-syllabic) |

Each stimulus item was printed in black ink on a 5 x 7 inch white note card resulting in three stumulus items for each set. Each stimulus card was placed in a ring binder to facilitate ease of presentation. In Set # 1 the word "cup" was presented on the left hand card and the word "ray" on the right hand card. For the next trial, the word "cup" was presented on the left hand card and the word "pray" on the right hand card. The third trial consisted only of the word "pray" presented on the right hand card. This procedure was followed for each of the four sets.

Verbal instructions given to each subject were:

> "You are going to see two cards flipped over this board. Each card will contain one word. Your job is to make one 'funny big word' out of the two words that you see. Remember, make one 'funny big word' without stopping between them. Ready?"

A training session preceded the experimental session with each subject. The training words follow:

| | | |
|---|---|---|
| Set # $Tr_1$: | bus cat | (inter-syllabic) |
| | bus scat | (intra-syllabic) |
| | scat | (intra-syllabic) |
| Set # $Tr_2$: | house top | (inter-syllabic) |
| | house stop | (intra-syllabic) |
| | stop | (intra-syllabic) |

After the subject had shown proficiency in the training session items, that is, he had produced the stimulus items without stopping between them, the experimental items were then presented. Each subject received one trial per combination, resulting in three responses per subject per set. A total of 240 responses were obtained from the 20 subjects and were recorded for analysis.

Instrumentation

All experimental test items were recorded on an Ampex Model 602-2 tape recorder. Scotch Brand Magnetic recording tape, 1/4 inch x 1200 feet (6.35 mm x 720 m) silicone lubricated, 1.5 mil acetate backing, was used at an operating speed of 15 inches per second. A Unidyne unidirectional microphone, Model number 5565, with matched impedence of 0.5 MΩ was placed twelve inches from the speaker. The recorded intensity level remained constant for all subjects as evidenced by the maximum displacement of the intensity meter level indicator. From the Ampex tape recorder the signal for each subject's response was passed with appropriate impedence matching, 30 ohm balanced input, into a

Kay Electric sound spectrograph, Sona-Graph Model Recorder. For each subject twelve sonograms were obtained. The Range Switch was set for the frequency regions from 85 cycles to 6,000 cycles. The horizontal distance covered by one sonogram was 318.5 millimeters representing 2.4 seconds in time. The Band Selector for the scanning filter was set for a wide band (300 cycles). The Shaping Switch was set at the recommended HS position.

The specification of the acoustic characteristics of the consonant blends under consideration necessitated the measurement of the interval from the initiation of the consonantal stop spike to the termination of the r-glide in both intra-syllabic and inter-syllabic blends. The criteria used in establishing the sound segments to be measured were based upon those established in the literature (Fant, 1958; Joos, 1948; Potter, et al, 1947).

## Data Analysis

The specific procedures for data analysis for the present investigation are listed below in regards to the questions which were posed at the onset.

1. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /pr/ blends?
2. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /tr/ blends?

3. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /gr/ blends?

4. Is there a statistically significant difference of duration between intra-syllabic and inter-syllabic /br/ blends?

Durational measurements of the acoustical specifications for all blend combinations under consideration were taken from each sonogram in millimeters accurate to ± 0.5 mm. A one-way analysis of variance technique was used to answer the above questions in which a general hypothesis of no difference among the means of the various groups is tested. A test for significance of differences of the two types of groups (intra-syllabic and inter-syllabic blends) was carried out by employing the H test (Downie and Heath, 1965).

# CHAPTER IV

## RESULTS AND DISCUSSION

The questions posed at the onset of this investigation were:

1. Is there a statistically significant difference of duration between inter-syllabic and intra-syllabic /pr/ blends?
2. Is there a statistically significant difference of duration between inter-syllabic and intra-syllabic /tr/ blends?
3. Is there a statistically significant difference of duration between inter-syllabic and intra-syllabic /gr/ blends?
4. Is there a statistically significant difference of duration between inter-syllabic and intra-syllabic /br/ blends?

### Statistical Measurements Employed

The Kruskal-Wallis H Test (Downie and Heath, 1965) was used to answer the questions listed above. The technique of measurement is used to test whether or not a group of independent samples is from the same or different populations.

In the present investigation the investigator assumed the null hypothesis that there was no statistically significant durational difference between inter-syllabic and intra-syllabic /r/ blends.

The results of the Kruskal-Wallis H test for the four /r/ blends investigated are shown in Table 1.

The null hypothesis of no statistically significant difference was rejected at the .05 level of confidence for a two-tailed test of the /tr/ blend. Since the samples contained five or more cases, the H was interpreted as chi square with the number of samples minus one degree of freedom. The chi square value at the .05 level with 2 degrees of freedom is 5.991. The H-test yielded a value of 3.82 which is significant at the .05 level of confidence (Downie and Heath, 1965, p. 311). As shown by the Kruskal-Wallis H test, a statistically significant difference of duration did exist between inter-syllabic and intra-syllabic /tr/ blends.

The null hypothesis that no statistically significant difference existed between inter-syllabic and intra-syllabic /pr/ blends was likewise rejected at the .05 level of confidence for a two-tailed test of the /pr/ blend. Since the samples again contained five or more cases, the H was interpreted as chi square with the number of samples minus one degree of freedom. The chi square value at the .05 level with 2 degrees of freedom is 5.991; the H test yielded a value of 5.64 for the /pr/ blend which is significant at the .05 level of confidence (Downie and Heath, 1965, p. 311). Consistent with the findings on the /tr/ blend, the /pr/ blend, as tested in "cup/ray," "cup/pray" and "pray,"

Table 1.--Kruskal-Wallis H-test for significance of duration between inter-syllabic and intra-syllabic /pr/, /tr/, /gr/ and /br/ blends.

| Blend | H-test |
|---|---|
| /tr/ | 3.82* |
| /pr/ | 5.64* |
| /gr/ | 13.39 |
| /br/ | 18.89 |

* Significant at .05 level for two-tailed test.

exhibited a statistically significant difference of duration between inter-syllabic and intra-syllabic /pr/ blends.

The null hypothesis of no statistically significant difference was accepted at the .05 level of confidence for a two-tailed test of the /gr/ blend. Since the samples once again contained five or more cases, the H was interpreted as chi square with the number of samples minus one degree of freedom. The chi square value at the .05 level with 2 degrees of freedom again is 5.991. The H test carried out for the /gr/ blend yielded a value of 13.39 which is not significant at the .05 level of confidence (Downie and Heath, 1965, p. 311). Contrary to the findings of the /tr/ and /pr/ blends, the /gr/ blends as tested in "pig/ray," "pig/gray" and "gray," did not exhibit a statistically significant durational difference.

The null hypothesis was likewise accepted at the .05 level of confidence for a two-tailed test of the /br/ blend. The samples contained five or more cases; therefore, the H was interpreted as chi square with the number of samples minus one degree of freedom. The chi square value at the .05 level of confidence with 2 degrees of freedom is 5.991. The H test for /br/ yielded a value of 18.87 which is not significant at the .05 level of confidence (Downie and Heath, 1965, p. 311). As with the /gr/ blend a statistically significant durational difference did not exist for the /br/ blend.

Since the null hypothesis was accepted rather than rejected for the /gr/ and /br/ blends, it was assumed that there were no statistically significant differences between the time lapses as they occurred in the blend elements in inter-syllabic and intra-syllabic contexts, as tested by this study. These non-significant H tests might seem to indicate that if perceptual differences do exist in the articulations of the /gr/ and /br/ blends, these perceptual differences would not be manifested in durational differences of statistical significance.

However, the null hypothesis was rejected for the /tr/ and /pr/ blends. The H tests of these blends indicate that there were statistically significant differences between the time lapses as they occurred in the blend elements in inter-syllabic and intra-syllabic contexts.

In an effort to further explore possible differences between the three stimulus cases (inter-bisyllabic, intra-bisyllabic and intra-monosyllabic) in each of the significant blend contexts, /tr/ and /pr/, the Mann-Whitney U test was calculated for each blend (Downie and Heath, 1965, p. 323). In this study, the investigator attempted to determine what combination or combinations of the three samples came from the same population. The results of the Mann-Whitney U's are found in Table 2. In all three cases for the /tr/ blend, a significant U was obtained and the null hypothesis was

TABLE 2.--Mann-Whitney U Tests for /tr/ and /pr/ blends to determine if three case (inter-bisyllabic, intra-bisyllabic and intra-monosyllabic) come from the same population.

| Blend | *Groups Compared | Mann-Whitney U | $N_1$ | $N_2$ | Critical Value of U for Two-Tailed Test at .05 | +Significance/ Non-Significance |
|---|---|---|---|---|---|---|
| /tr/ | #1 and #2 | 119.5 | 20 | 20 | 127 | +Significant |
| | #1 and #3 | 64.5 | 20 | 20 | 127 | +Significant |
| | #2 and #3 | 55.0 | 20 | 20 | 127 | +Significant |
| /pr/ | #1 and #2 | -132.0 | 20 | 20 | 127 | Non-significant |
| | #1 and #3 | 86.5 | 20 | 20 | 127 | +Significant |
| | #2 and #3 | 45.5 | 20 | 20 | 127 | +Significant |

*Group #1--inter-syllabic (bisyllabic)
Group #2--intra-syllabic (bisyllabic)
Group #3--intra-syllabic (monosyllabic)

+Significant at .05 level of confidence

therefore rejected. The obtained U values indicate that there are statistically significant differences between the time lapses as they occur in inter-syllabic (bisyllabic), intra-syllabic (bisyllabic) and intra-syllabic (monosyllabic) contexts. Therefore, for the /tr/ blend there is a statistically significant durational difference between the mode of stimulus presentation. That is, the context in which the stimulus is presented does effect the duration of the blend for the /tr/ as indicated by the stimulus words investigated in this study.

For two of the three /pr/ cases, a significant U was obtained and the null hypothesis was rejected. These cases compared the inter-syllabic (bisyllabic) context with the intra-syllabic (monosyllabic) context and the intra-syllabic (bisyllabic) with the intra-syllabic (monosyllabic) context. One case, comparison of the inter-syllabic (bisyllabic) context with the intra-syllabic (bisyllabic) context, yielded a nonsignificant U value. This was interpreted to mean that there are no statistically significant difference between the time lapses as they occur in inter-syllabic and intra-syllabic /pr/ blends when both are bisyllabic utterances.

An interesting pattern was found to exist in Table 2 for the Mann-Whitney U values. Five of the six inter-group comparisons yielded values which indicated statistically significant differences do exist between the groups compared for both the /tr/ and /pr/ blends. Only one comparison,

inter-bisyllabic with intra-bisyllabic /pr/ blend, yielded a statistically nonsignificant difference. In every case where significant differences were shown, Group #1 (inter-bisyllabic) influence accounted for the magnitude of difference. The intra-bisyllabic and intra-monosyllabic combinations for both blends yielded the least degree of durational difference. Although one case, comparing the inter-bisyllabic and the intra-bisyllabic /pr/ context, did not yield a significant U value, when each component of that case was compared to the remaining intra-monosyllabic context, the pattern held true. That is, the inter-bisyllabic context influences the durational difference to a greater extent than either the intra-bisyllabic or the intra-monosyllabic context.

This indicates that the significant Mann-Whitney U values for the three cases compared, rank order themselves on a lawful basis. These values are reflected by syllable boundaries. Greater durational differences were found in inter-bisyllabic contexts than in either intra-bisyllabic or in inter-monosyllabic contexts. Least durational differences were found in the intra-monosyllabic contexts than in either the inter-bisyllabic context or the intra-bisyllabic context.

## Implications of Results

The premise of the McDonald Deep Test of Articulation is that the production of the sound element is strongly influenced by the phonetic context in which it is placed.

McDonald (1964) has described speech as a series of overlapping, ballistic type movements of the articulators in which single sounds as well as words are blended into a total framework of the utterance.

The four most frequently occurring initial /r/ blend combinations in the English language, in rank order, are /pr/, /tr/, /gr/ and /br/ (Griffith and Miner, 1973). The McDonald Deep Test of Articulation, however, tests only the /br/ blend, the fourth ranking blend. Results of the present investigation have indicated that for the two most frequently occurring /r/ blend combinations, /tr/ and /pr/, the mode of stimulus presentation has a direct effect on the duration of the blend. This study has cast doubts upon McDonald's contention that the inter-syllabic and intra-syllabic contexts of blends <u>might be sufficiently similar</u> (underscore added) that it is not necessary to test both. The findings of this study appear to substantiate Garrett's (1972) doubts about the validity of McDonald's contention that a bisyllabic utterance is an adequate sample of "connected speech." In support of the test, however, Garrett states that it includes a more controlled and representative sample of articulatory behavior than the conventional three position test. Further he states that McDonald has probably as valid a test as any today. This investigator agrees with Garrett---the deep test is a step in the right direction

although it does not allow for frequency of occurrence of /r/ blends and for examination of intra-syllabic /r/ blends.

The present investigation has shown that a statistically significant difference of duration does exist between the intra-syllabic and inter-syllabic contexts of the voiceless stop-r glide combinations /pr/ and /tr/ and the voiced stop-r glide combinations /gr/ and /br/. These findings are consistent with those found in the experimental phonetics literature.

Miller and Nicely (1954) provided a brief yet comprehensive statement regarding voicing as a linguistic feature in the classification of phonemes. They have reported that voiceless consonants are aperiodic (noisy in character) and more intense (contain more spectral energy) than the voice consonants which are periodic (contain a line-spectrum component superimposed on noise) and less intense. Specifically, voiceless stops have considerable aspiration, a breathy noise between the release of pressure and the beginning of the following vowel, and may be somewhat briefer than the voiced stops.

In a study on the influence of consonant enrionments upon the secondary acoustical characteristics of vowel, House and Fairbanks (1952) found that the durational means of the vowels varied systematically with certain characteristics of consonant production. One feature compared voiceless environments with voiced environments. They also found that in every

case, (1) the voiced environments were of longer duration than the voiceless environments and (2) that the stop plosives were shorter in duration than either the fricative or nasal groups. It appears that, based on the results of this investigation and of those reported above, the duration of is shorter for voiceless environments than for voiced environments and, specifically, that voiceless stop-plosives have durational intervals shorter than voiced stop-plosives. One now needs to consider the influence of the /r/ upon the /p/ and /t/ when they occur in blend combinations.

Considerable disagreement appears to abound in the literature about the nature of the /r/ consonant element. Hanley-Thurman (1970) classify it as a voiced, palatal glide, while others classify it as a semi-vowel. This investigator agrees with Hanley-Thurman.

The /r/s in the /pr/ and /tr/ blends are referred to as front fricative /r/s; the "front" referring to place of articulation and the "fricative" referring to the frictional modulation that is present in the transition between the stop spike and the first phase of the /r/. The position of the energy hubs, other resonance bars at the initiation of voicing, and the transitional nature of their patterns, all indicate that the /r/s are glides produced with frictional, vocal cord, and varying cavity modulation; and that the fricative portion of the glide is related to the transition from stop-frictional

modulations. Potter, et al. (1947) provide a convincing summary regarding /r/ blends: "Variations in speed and precision of articulation modify the duration of the steady state phase of the /r/ and also the relative duration of the fricative and voiced components" (p. 46).

The evidence is convincing that there is a significant difference of phonation onset time between voiced and voiceless consonant-vowel environments, and, as this study tends to indicate, between voiced and voiceless /r/ blends.

The results of the present investigation seem to indicate that these parameters, frequency of occurrence of /r/ blends, examination of intra-syllabic /r/ blends, and examination of voiceless stop-r blends, must be considered significant features to be considered in the construction of an articulation test.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

The purpose of this investigation was to determine the equivalence of compound consonant sequences and abutting consonant sequences for deep testing articulatory ability for the /pr/, /tr/, /gr/ and /br/ blends. The question posed at the onset of this investigation was: Is there a durational difference between the articulation of the two sound components of the four most frequently occurring /r/ blends, /tr/, /pr/, /gr/ and /br/; and if there is, is this difference statistically significant when the blends are tested in inter-syllabic and intra-syllabic contexts.

Twenty subjects (ten boys and ten girls), from 8 years, 2 months to 9 years, 1 month, were randomly selected from third grades at public schools in the East Central Illinois Speech and Hearing Association region. The subjects met the criteria of normal intelligence and no articulation errors.

The stimulus words used in the investigation were:

| | | |
|---|---|---|
| Set # 1: | cup ray | (inter-syllabic) |
| | cup pray | (intra-syllabic) |
| | pray | (intra-syllabic) |
| Set # 2: | kite rain | (inter-syllabic) |
| | kite train | (intra-syllabic) |
| | train | (intra-syllabic) |

| | | |
|---|---|---|
| Set # 3: | pig ray | (inter-syllabic) |
| | pig gray | (intra-syllabic) |
| | gray | (intra-syllabic) |
| Set # 4: | tub rake | (inter-syllabic) |
| | tub brake | (intra-syllabic) |
| | brake | (intra-syllabic) |

The subjects were instructed to make a "funny big word" out of the words presented without stopping between them. They were allowed to proceed with the test only after they displayed proficiency in the task as evidenced by the two practice sets that were administered. Twelve responses per subject, resulting in a grand total of 240 responses, were recorded on am Ampex tape recorder and subsequently fed into a sound spectrograph yielding in 240 sonograms. An acoustical analysis of each sonogram required the measurement of the interval from the initiation of the consonantal stop spike to the termination of the r-glide in both intra-syllabic and inter-syllabic /r/ blends. Measurements were made in millimeters accurate to .05 mm.

The Kruskal-Wallis H test was used to test a general null hypothesis of no statistically significant difference among the means of the various sub-groups (/pr/, /tr/, /gr/ and /br/ blend contexts). The results of the statistical analysis indicated that there were no statistically significant differences of duration for the /gr/ and /br/ blend contexts. These non-significant H values might possible indicate that if perceptual differences do exist in the articulations

of the /gr/ and /br/ blends tested, these perceptual differences would not be manifested in durational differences.

In an effort to further explore possible differences between the three stimulus cases, inter-syllabic (bisyllabic), intra-syllabic (bisyllabic) and intra-syllabic (monosyllabic), in each of the significant blend contexts, /tr/ and /pr/, the Mann-Whitney U test was calculated for each blend. In all three cases for each blend, a statistically significant U was obtained; this finding indicates that there are statistically significant differences between the time lapses as they occurred in inter-syllabic (bisyllabic), intra-syllabic (bisyllabic) and intra-syllabic (monosyllabic) contexts. The inter-bisyllabic context extends over a longer interval of time than either the intra-bisyllabic or the intra-monosyllabic contexts. The intra-monosyllabic context appears to be the most facilitating, at least in terms of time, conveyor of the /tr/ and /pr/ blends. Therefore, for the /tr/ and /pr/ blends there is a statistically significant durational difference between the mode of presentation. The context in which the stimulus is presented does effect the duration of the blend for both /tr/ and /pr/.

## Conclusions

Nine conclusions were drawn from the results obtained in the present study:

(1) This investigation provides evidence that inter-syllabic and intra-syllabic /pr/ blends are different with respect to the durational interval that occurs between the articulation of the two blend components in the inter-syllabic and intra-syllabic contexts;

(2) This investigation provides evidence that inter-syllabic and intra-syllabic /tr/ blends are different with respect to the durational interval that occurs between the articulation of the two blend components in the inter-syllabic and intra-syllabic contexts;

(3) This investigation provides no evidence that inter-syllabic and intra-syllabic /br/ blends are different with respect to the durational interval that occurs between the articulation of the two blend components in the inter-syllabic and intra-syllabic contexts;

(4) This investigation provides no evidence that inter-syllabic and intra-syllabic /gr/ blends are different with respect to the durational interval that occurs between the articulation of the two blend components in the inter-syllabic and intra-syllabic contexts;

(5) The mode of stimulus presentation, inter-syllabic (bisyllabic), intra-syllabic (bisyllabic) or intra-syllabic (monosyllabic), has a direct effect on the duration of either the /pr/ or /tr/ blend.

(6) The intra-monosyllabic context has a shorter duration

than either inter-bisyllabic context or the intra-bisyllabic context for /tr/ and /pr/ blends.

(7) The intra-bisyllabic context has a shorter duration than the inter-bisyllabic context for /tr/ and /pr/ blends.

(8) Since the only common denominator of similarity between the /pr/ and /tr/ blends is that they both are voiceless stop r-glide combinations and that the only common denominator of dissimilarity between these and the /gr/ and /br/ blends (both voiced stop r-glides), it appears that voicing is a distinctive feature possibly accounting for the perceptual differences.

(9) The McDonald Deep Test of Articulation, which does not consider frequency of occurrence of /r/ blend contexts and which does not evaluate intra-syllabic /pr/ and /tr/ contexts, may not be a valid indicator of articulation behavior for the /pr/ and /tr/ blend contexts.

The results of this investigation suggest that the articulatory positions for producing the /pr/ and /tr/ blends (both inter-syllabic and intra-syllabic <u>are not sufficiently similar</u> to warrant the testing of these blend contexts in only inter-syllabic positions.

A perceptual analysis of the /r/ blends in the two contexts is now indicated. Research must provide clinical utility for the technical data it provides. An acoustical analysis must now be supplemented by a perceptual analysis of the /r/ blends to provide clinically useful information.

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