RECOGNITION OF THREE MAGNITUDES OF
INTERPHONEMIC TRANSITIONAL INFLUENCE

DISSERTATION

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GEORGE JAMES HARBOLD, B.A.E., M.A.

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Approved by:

Adviser
Department of Speech

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TABLE OF CONTENTS

<u>CHAPTER</u>	<u>PAGE</u>
I INTRODUCTION AND STATEMENT OF THE PROBLEM...	1
Introduction	1
Statement of the Problem	15
II PROCEDURE	17
Selection of Stimuli	17
Recording	18
Administration	18
III RESULTS AND DISCUSSION	22
Results	22
Discussion	25
IV SUMMARY AND CONCLUSIONS	28
Summary	28
Conclusions	28
REFERENCES	30
APPENDIX A	32
APPENDIX B	34

TABLE OF TABLES

<u>TABLE</u>		<u>PAGE</u>
I	Results of Analysis of Variance for Main Effects	23
II	Summary of Evaluation of Simple Effects of Transems and Positions	24
III	Means for Positions for Each Transeme	25

TABLE OF FIGURES

<u>FIGURES</u>		<u>PAGE</u>
I	Equipment for Presenting Stimuli to Listeners	21

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

Quantification of speech materials had its beginning shortly after the turn of this century when the telephone industry initiated a program designed to investigate the nature of the stimuli being transmitted over its system. Bell Telephone Laboratories began an analysis of the characteristics of speech sounds and an investigation of hearing designed

... to get an accurate physical description and a measure of the mechanical operation of human ears in such terms that we may relate them directly to our electrical and acoustical instruments, to test the keenness of the sound-discriminating sense and find what is the smallest distortion which the mind can perceive and how it reacts to somewhat larger distortions; and thus to reach a reasonable basis of design both for separate instruments and for systems as a whole, to give a proper balance between cost and performance.¹

¹Harvey Fletcher, Speech and Hearing, New York, D. Van Nostrand Co., 1929, p. xii.

An early report of the pioneer efforts of Campbell, Crandall, Scacia, Beck, Fletcher, and others, was published in 1929 by Fletcher.² Initial measurements were not concerned with

²Ibid., p. xii.

the speaker, but with phonetic elements and the evaluation of telephone equipment.³ One significant contribution was

³Hess Haagen, "Intelligibility Measurement," Speech Monographs, Vol. XIII, 1946, pp. 4-7.

the development of better and more precise instruments which would convert sound waves into electrical form and then reconvert them to sound with a minimum of distortion. Also, techniques and procedures that were devised and utilized for testing articulation recognition laid the groundwork for subsequent developments in intelligibility testing.

After Fletcher's 1929 report, a wealth of new information bearing upon the problem of speech intelligibility became evident in the literature. Some of the research came from the Bell Telephone Laboratories but other centers also made noteworthy contributions.⁴ One example is the

⁴Harvey Fletcher, Speech and Hearing in Communication, New York, D. Van Nostrand Co., 1953, p. vi.

work at Harvard University Psycho-Acoustic Laboratories in the development of speech tests for the evaluation of military communication equipment and systems. These efforts to develop word lists which measured intelligibility resulted in the development of the Harvard Auditory

Tests.^{5,6} Many modifications, revisions, and applications

⁵C. V. Hudgins, J. E. Hawkins, J. E. Karlin and S. S. Stevens, "The Development of Recorded Tests For Measuring Hearing Loss For Speech," Laryngoscope, Vol. 57, 1947, pp. 57-89.

⁶J. P. Egan, "Articulation Testing Methods," Laryngoscope, Vol. 58, 1948, pp. 956-991.

of these tests have been reported. At about the same time the Voice Communication Laboratory assumed the job of developing a program of testing intelligibility of speakers rather than equipment or sounds.⁷ Military needs were also

⁷Haagan, op. cit., pp. 4-7.

responsible for another significant development in communications research.

A spectrograph development project was started early in 1941. American participation in the war emphasized the military application of, and needs for, a visual translation of sound, and during the war period major interest was centered upon these military requirements.⁸

⁸Ralph K. Potter, G. A. Kopp, Harriet C. Green, Visible Speech, New York, D. Van Nostrand Company, Inc., 1947, p. 4.

It was only after the military needs had been met that the opportunity was offered for a resumption of the development of visible speech toward the original goal of "visual

hearing." Because of military interests, publication of information concerning the nature or progress of the project was delayed until the end of the war. Data thus made available to phoneticians, linguists, and communication researchers had the effect of generating an emphasis in communication investigations that had previously been impossible. Curtis⁹ referred to this when he stated,

⁹J. F. Curtis, "Systematic Research in Experimental Phonetics: 3. The Case For Dynamic Analysis in Acoustic Phonetics," Journal of Speech and Hearing Disorders, Vol. 19, 1954, p. 148.

Instead of assuming that the essential characteristics of speech could be described by an essentially cross-sectional type of analysis, they have employed more dynamic analytical procedures in which the variations occurring in time which result from the interlinking of sounds in sequence have begun to be investigated for their own sake, to see if these features of the continuous flow of speech may not yield cues which aid in the listener recognition of sounds.

As indicated, the hope of identifying and delineating phonemic elements of speech in terms of some constant physical feature or combination of features has been diminished as a result of the recent development of sound analysis techniques and facilities. This "failure" on the part of the laboratory worker has forced on linguists a sharper realization of the number and type of operations mediating between the perception of an utterance as a

physical event and the phonemic analysis of the same.¹⁰

¹⁰Leigh Lisker, "The Distinction Between [œ] and [ɛ]," Language, Vol. 24, 1948, pp. 397-407.

Similarly, as more information about acoustical signals became available to researchers and as more of the physical information in the acoustic wave became available, there resulted a pronounced emphasis on the study of the acoustical structure of speech signals with particular regard to the manner in which the intelligible structure of speech is derived from its acoustical characteristic. According to Curtis,¹¹ most of the early intelligibility research was

¹¹Curtis, op. cit., p. 148.

based on certain assumptions about the code units, namely, that (1) continuous flow of speech can be broken down or "quantized," (2) suitable acoustic analysis would yield a single set of values for each of the phonetic units which would be adequate to specify its significant acoustical characteristics, and (3) time variations, which are known to occur when sounds are spoken in context, are unimportant by-products of the process of linking sounds together. A more recent point of view, which is to the contrary, has

been expressed by Kock and Miller by the statement,

In studies of speech which are undertaken to determine in what factors the information is contained, one is soon impressed with the fact that a large number of phonemes are intimately associated with rapid changes in the spectrum content of the sound....Also pointing to the suggestion that perhaps these changes in spectrum are important is the observed fact that steady sounds tend to lose their meaning if they are prolonged.¹²

¹²W. E. Kock and R. L. Miller, "Letters to the Editor," Journal of the Acoustical Society of America, Vol. 24, 1952, p. 783.

A single energy-frequency-time segment of a vowel will reveal little, if any, of this transitional influence that is present in connected speech. "Actually a vowel in a word...undergoes transitional movements from initial to final consonants. Not only does the spectrum of the vowel change with time, but the ear in identifying the word has the benefit of all the changes."¹³ Since movement is a

¹³R. K. Potter and J. C. Steinberg, "Toward the Specification of Speech," Journal of the Acoustical Society of America, Vol. 22, 1950, pp. 807-820.

distinguishing characteristic of speech, it seemed logical to assume that the complex acoustical patterns represented by words are not adequately represented by a single cross-section. Intensity of the vowel sounds is carried largely by the harmonics of the voice, each having its particular

frequency region of concentration or prominence. Consonant sounds similarly have their own frequency region characteristic. Therefore, when these speech sound types are combined to form speech code units, the result is a "continuous succession of rapid variations in intensity, not only in particular frequency regions but also along the frequency scale. The interpretation of speech received by the ear depends upon the perception and recognition of these constantly shifting patterns."¹⁴

¹⁴N. R. French and J. C. Steinberg, "Factors Governing the Intelligibility of Speech Sounds," Journal of the Acoustical Society of America, Vol. 19, 1947, p. 100.

Visible patterns of energy distribution clearly demonstrate these variations in intensity distribution. Furthermore, these patterns indicate that articulators spend about as much time in transitional movements as they spend in characteristic or steady state positions.¹⁵ It follows

¹⁵Potter, Kopp, and Green, op. cit., p. 39.

that the study of speech sounds from the point of view of spectrum analysis is indicated. Cooper¹⁶ has listed three

¹⁶F. S. Cooper, "Spectrum Analysis," Journal of the Acoustical Society of America, Vol. 22, 1950, p. 761.

such things in the order of increasing importance, "the fact that familiar techniques and concepts are utilized. Second, that spectrum analysis is a 'natural' way in which to think of auditory phenomena, since the ear itself appears to perform frequency analysis. But perhaps the most important reason depends upon the fact that the end result of spectrum analysis is a spectrogram." The organization of the desired information into a "picture" thus permits the investigator to deal with the dynamics of speech and makes possible the investigation of what is perhaps the central problem of speech analysis, namely, the invariants of speech.

Several investigators have suggested that it is probable that important cues to sound recognition can be attributed to transitional variations in the sound spectrum, and that the way in which formant frequencies are influenced during transitions toward and from the central portion of a vowel probably could provide cues to the identification of the sound combinations. As early as 1929, Fletcher¹⁷ reported that "A consonant sound may

¹⁷Fletcher, (1929), op. cit., p. xii.

sometimes be identified by the modification produced on the following or preceding vowel even though it is below the threshold as determined by an isolated sound." He further suggested that this modification might logically be

considered as part of the consonant, which implied that the threshold of the consonant in some instances would vary with the threshold of an adjacent vowel. Black¹⁸ later

¹⁸J. W. Black, "The Effect of the Consonant on the Vowel," Journal of the Acoustical Society of America, Vol. 10, 1939, pp. 203-205.

reported results of a study which considered differences in the physical composition of vowels in consonant-vowel combinations. By means of an Henrici analyzer, harmonic analyses were made of consecutive waves of the vowels and it was concluded that these physical patterns vary within the speech of one subject when the vowel is bounded by different consonants. About ten years later Potter and Peterson¹⁹ referred to this same influence as a bending of

¹⁹R. K. Potter and G. E. Peterson, "The Representation of Vowels and Their Movements," Journal of the Acoustical Society of America, Vol. 20, 1948, p. 535.

the vowel bars and it was suggested that "it will be possible to determine equally distinguishable steps of vowel change or equal phonetic intervals for the average ear, so that a coordinate system could be constructed in which equal shifts in any direction would produce an equivalent change in the vowel sound." Sherman²⁰ investigated "audible cues

²⁰Dorothy Helen Sherman, "A Study of the Influence of Vowels on Recognition of Adjacent Consonants," Journal of Speech and Hearing Disorders, Vol. 17, 1952, pp. 198-212.

or lack of such cues during the transitional period from the consonant to the vowel and from the vowel to the consonant" to determine whether the presence of such cues might aid in identifying the consonant. Sherman considered it possible that a consonant, requiring relatively large changes in intensity to produce much change in probability of correct recognition, is recognized as a function of changes effected upon the adjacent vowel in addition to the intensity function. In general, the results supported the hypothesis that there was variation in the per cent recognition of a consonant concomitant with variation of the adjacent vowel. However, evidence did not indicate that variation in consonant recognition could be predicted by the influence on the physical pattern of bar 2 of the vowel spectrogram. In a study of vowel recognition as a function of three variables, Tiffany concluded that his evidence seemed

...to indicate that for a complete specification of the spoken vowel not only must there be provided the information about its energy-frequency distribution at a given instant in time, but also there must be provided certain items of information concerning the way in which it varies in the contextual speech pattern.²¹

²¹W. R. Tiffany, "Vowel Recognition As a Function of Duration, Frequency Modulation and Phonetic Context," Journal of Speech and Hearing Disorders, Vol. 18, 1953, p. 300.

Another method of investigating information-bearing elements of speech employs synthesized signals. This method has underscored the importance of transitional variations, assigning to them a bigger role than in previous investigations based on the assumption that speech could be separated into independent units. For example, Harris²² employed speech which was built up from a selected

²²C. M. Harris, "A Study of Building Blocks of Speech," Journal of the Acoustical Society of America, Vol. 25, 1953, pp. 962-969.

group of sounds that were regarded as building blocks of speech. His experiments indicated that with one building block for each vowel and consonant, resulting speech "not only sounds unnatural but is mostly unintelligible, because the influences on vowel and consonants are missing which ordinarily occur between adjacent speech sounds."²³ Harris

²³Ibid., p. 969.

maintained that synthesized speech must include the influence factor if its reasonable naturalness, as well as intelligibility, is to obtain. Another recently reported study, from Haskins Laboratories, has demonstrated that it is highly probable that important cues to consonant

perception are inherent in interphonemic transitions.²⁴ It

²⁴F. S. Cooper, P. C. Delattre, A. M. Liberman, J. M. Borst, and L. J. Gerstman, "Some Experiments on the Perception of Synthetic Speech Sounds," Journal of the Acoustical Society of America, Vol. 24, 1952, pp. 597-606.

was found that direction and extent of frequency changes in formants of synthetic speech sounds can serve as effective cues for the identification of certain phones according to place of production. It was also suggested that the temporal course of these changes might provide a basis for distinguishing among certain classes of speech sounds that differ in manner of production. Specifically on this matter, Gerstman et al²⁵ later reported that tempo of change

²⁵L. J. Gerstman, A. M. Liberman, P. C. Delattre and F. S. Cooper, "Rate and Duration of Change in Formant Frequency as Cues for the Identification of Speech Sounds," (Contributed Papers), 47th Meeting of the Acoustical Society of America, New York, New York, 1954.

between two fixed formant frequencies was found to be sufficient "to enable naive listeners to distinguish rather reliably among stop-consonant-plus-vowel (e.g. ba), semi-vowel-plus-vowel (e.g. ua).²⁵ They stated further that additional experiments suggest that duration of frequency changes were more important than the rate at which these

changes occur. Another similar study by Liberman et al²⁶

²⁶A. M. Liberman, P. C. Delattre, F. S. Cooper, and L. J. Gerstman, "The Role of Consonant-Vowel Transitions in the Perception of the Stop and Nasal Consonants," Psychological Monographs, Vol. 68, 1954, pp. 1-13.

concerned with the perception of stop and nasal consonants points out the significance of direction and degree of second-formant transitions as cues for perceived distinctions among stop consonants. Second-formant transitions were considered to have essentially the same effect within each of two classes of stop-consonants (voiced and voiceless) employed and the results were treated as if each of the cognate pairs (p - b, t - d, and k - g) were a single sound. It was found that duration of transition was also a cue, not within the class of stop consonants, but between this class and others. It is interesting to note that minus transitions, i.e. downward shift in frequency, were heard as t - d or g - k depending on the size of transition and the vowel with which it was paired.

In summary, during the past half century quantification of speech materials has evidenced a rapid and changing development. The aspects of this development which have been included here are not to be regarded as an attempt to survey the literature. Rather, from the literature there have been selected particular references in an effort to

point up certain conclusions: (1) regardless of the tremendous developments in facilities and techniques for research in acoustics, code units of speech are as yet not satisfactorily determined, (2) data from spectrographic facilities and techniques have given cause for researchers to re-examine some of the "facts" that were established prior to the availability of a dynamic approach to the study of speech codes, (3) transitional influence has been recognized by many researchers, treated as a contributing factor by some, and considered as an entity (only by implication) by others. Therefore, study of transitional influence employing speech signals is indicated as a possible source of information which might contribute to the efforts that are being made to understand the speaking process. In this study the use of words, tailored to fit transition class, was considered but was discarded because such stimuli would be unavoidably sensitive to the variables that affect word recognition. The technique for employing actual speech in an effort to abstract or isolate "transitioness" seemed to be the use of spoken signals with a minimum of "wordness." This would remove recognition advantages that "wordness" offers. The technique of employing structured monosyllables of CV, VC, and CVC forms was adopted on the assumption that success of recognition of nonsense syllables depends on their

phonetic composition. Also, by selecting vowels and consonants with respect to characteristic hub location, discrete classes of transition influences could be structured. It has been the practice of linguists to denote a family of like phenomena with the suffix eme and discrete occurrences of phenomena belonging to the family with the prefix allo. Since this problem involved the grouping of transitional influences and since these occurrences constituted allotypes, a family of transitional events was designated as transeme, and discrete occurrences were termed allotrans.

Statement of the Problem

It was the purpose of this study to investigate the interphonemic transitional influence that results from sound combinations of spoken speech. Monosyllables of the CV, VC, and CVC were structured to provide three discrete magnitudes of transition (or transems) namely: Minimum, Medium, and Maximum. Underlying the study were the experimental hypotheses that:

1. Transems exist as entities and their allotrans would be correctly identified by listeners as belonging to their respective transems.
2. Transems of greater magnitude would be recognized more accurately than would transems of lesser magnitude.
3. Initial allotrans for each transeme would be recognized with greater accuracy than final allotrans of the same transeme.

4. Initial allotrans for all transeemes would be recognized more accurately than final allotrans for all transeemes.

CHAPTER II

PROCEDURE

Selection of Stimuli

High and low hub vowels, [i] and [u] respectively, were combined with the high, "mid," and low hub consonants, [ʃ,ʒ,tʃ,dʒ], [s,z,t,d], and [f,v,p,b] respectively. Each consonant was combined with each vowel so as to provide both consonant-vowel and vowel-consonant representations of minimal, medial, and maximal transitional influence. Minimal influence refers to transition between two speech sounds of similar hub type, i.e. high hub consonant to high hub vowel, etc. Medial influence would be that resulting from the influence of a "mid" hub position to either a high or low hub position. Maximal influence results from transition between high and low hub sounds. The resulting degrees of transitional influence constitute the families referred to earlier as transeemes. This classification concerns only magnitude and disregards direction of shift. To double the representation of each allotran in the stimulus list and also to provide extra precaution against influence of extraneous cues to the listeners, CVC syllables were structured in accordance with the above schema and included in the test list. Thus, the master test list consisted of 24 CV, 24 VC, and 24 CVC syllables with equal representation

among the transeemes as to position, degree and direction of influence, type of consonants employed, and vowel representation. (See Appendix A for listing of syllables employed.)

Recording

Six male speakers (four graduate students and two faculty members in the area of Speech Science) each recorded randomized lists of the 72 syllables at a single sitting. Each syllable was preceded by the carrier phrase "Number ___, you will write ___". Recordings were made on a 600 Ampex Magnetic Tape recorder, tape speed of 7 1/2 inches per second, with 21 B Altec (M 11 system) microphone lying along speaker's cheek with button at corner of mouth. Level was monitored for uniformity on the word "write." No limiting of signal was employed at any stage. These recordings were copied on a 305 Ampex thus affording both additional monitoring and speaker randomization to the tapes employed in testing.

Administration

Twenty-four college students served as listeners. Listeners selected had no more than 15 db hearing loss between 250 cps and 4000 cps as measured by a pure tone audiometer. Since 12 listening stations were available, subjects were divided into two panels of 12 each. A training period preceded the presentation of test recordings to

insure accuracy in the writing of responses. A level of 96 per cent accuracy in transcribing a randomized practice list of the syllables in quiet was accepted as the minimum criterion for proceeding with the test. Listeners gave written responses to the syllables by employing simple phonic representations of the sounds. This was found to provide accuracy and consistency in reporting. The two 12-man panels were trained and tested separately in the following manner: (1) explanation of the nature of the experimental task; (2) syllables presented with each sound demonstrated and transcribed; (3) practice in transcribing the syllables from dictation (live voice); (4) test for accuracy of writing responses employing a test tape of the syllables with all speakers represented (earphone presentation); and (5) practice with masking noise present.

Pre-test trial administrations were made to determine the efficacy of varying S/N ratios for this study. The range from +15 to +3 db S/N ratios afforded progressively more consonant impairment without loss of vowel identification. This provided for determining a ratio at which (1) vowels would be recognized, (2) consonants would be impaired or destroyed, and (3) transitional influence might determine the listeners' selection of consonants. Discrete 3 db steps from favorable to less favorable S/N ratios were adopted and listener responses were obtained

for the +15, +12, +9, +6, +3 and 0 db S/N ratios. Syllable and speaker orders were randomized for each presentation. Both panels responded to all speakers at one level per day. Figure I represents the equipment employed in presenting the stimuli through earphones to the two panels of listeners.

The rationale for the above techniques subsumes a correct response to be conditional upon the selection of sound combinations which involve transitions of correct magnitudes. Therefore, the criterion measure for scoring the responses was the correct magnitude of transition regardless of correct identification of speech sounds or direction of the transition shift. The +3db S/N ratio level was selected for analysis since it afforded a range of correct responses that was satisfactory for evaluation by the analysis of variance technique.

Figure I
Equipment for Presenting Stimuli to Listeners

CHAPTER III

RESULTS AND DISCUSSION

The data were evaluated by a triple analysis of variance in which the factors were position (O), transemes (T), and listeners (L). The categories of the position factor were (1) initial position and (2) final position; the categories of the transeme factor were (1) minimum transition, (2) medium transition, and (3) maximum transition.

The criterion measure was the number of correct responses for one listener for one transeme for one position with responses pooled for the six speakers. As previously indicated, a response was considered correct if the consonant was correctly identified or if a substituted response was correct with respect to the transeme involved. A complete table of criterion measures is presented in Appendix B.

The results of the analysis are presented in Table I. The F-test of interaction between transemes and positions is significant beyond the 1 per cent level. The differences between the position means thus varied from transeme to transeme.

In view of the significant interaction between positions and transemes, the differences between positions

and among transems were evaluated²⁷ separately for each

²⁷The error terms for these tests were the appropriate Mean Score values from Table I.

category of each factor. The results of this analysis are presented in Table II. All simple effects were significant with the single exception of the difference between positions for the medium transeme category.

Table I
Results of Analysis of Variance for Main Effects

Source	df	ss	ms	F	P
Position	1	1302	1302		
Transeme	2	10172	5036		
Listeners	23	2163	94		
PxT	2	511	255.5	10.47*	.001
PxL	23	453	19.7		
TxL	46	3348	72.8		
PxTxL	46	1122	24.4		
Total	143				

* $F = \frac{ms_{PxT}}{ms_{PxTxL}}$

The means for each Position and for each Transeme are presented in Table III. Differences required for significance were computed by employing the appropriate mean square values from Table I.²⁸ Evaluation of means in Table III

$$^{28}\text{Required difference} = t(2ms_{\text{error}/n})^{1/2}$$

Table II
Summary of Evaluation of Simple Effects of
Transemes and Positions

Source	df	ss	ms	F	P
Transemes _I	2	6108	3054	41.95 ¹	.001
Transemes _F	2	3597	1799	24.7 ²	.001
Positions _{Min.}	1	602	602	30.56 ³	.001
Positions _{Med.}	1	11.02	11.02	.56 ⁴	Nonsig.
Positions _{Max.}	1	1200	1200	60.9 ⁵	.001

1	$\underline{F} = ms_{T_I} / ms_{TxL}$
2	$\underline{F} = ms_{T_F} / ms_{TxL}$
3	$\underline{F} = ms_{P_{Min}} / ms_{PxL}$
4	$\underline{F} = ms_{P_{Med}} / ms_{PxL}$
5	$\underline{F} = ms_{P_{Max}} / ms_{PxL}$

along with differences required for significance indicates (1) Minimum Initials are significantly better recognized than Initials of either of the other two transemes, (2) Maximum Initials are significantly better recognized than the Medium Initials, (3) Minimum Finals are significantly better recognized than the Finals of the other two transemes, (4) there are no significant differences among Medium Initials, Medium Finals, and Maximum Finals with respect to listener responses. Therefore, the factor of position is

indicated as being important for Minimum and Maximum trans-emes but not for the Mediums.

Table III
Means for Positions for Each Transeme

<u>Position**</u>	<u>Transemes*</u>		
	<u>Minimum</u>	<u>Medium</u>	<u>Maximum</u>
Initial	88.96	66.88	74.08
Final	81.88	65.92	64.08

* c.d. = $t_{.01} (2ms_{TxL} / n)^{1/2} = 6.35$
 c.d. = $t_{.05} (2ms_{TxL} / n)^{1/2} = 4.82$

**The differences for positions were significant for Minimum and Maximum but not for Medium. See Table II.

Discussion

The results support the hypothesis that the three magnitudes of interphonemic influence are differentially recognized and identified. The mean score for each position for each magnitude indicated correct identification well beyond chance level. This is based upon the fact that out of the possibilities afforded for each response to Minimum and Maximum, four of these would result in a correct tally. Thus, a correct response could be achieved at a chance level of one in three. However, for the Medium,

eight out of 12 possibilities would be scored as correct on a chance basis **alone**. Therefore, a chance response for Medium was twice as likely as for the other two categories. This means that the responses to Minimum and Maximum may not be attributed to a chance factor but the chance factor may not be disregarded in the case of the Mediums. The implications of these results might be of profound importance in the study of language behavior. The results of the present study seem to imply that either "no" transition movement or "most" transition movement between speech elements can be handled satisfactorily by the speech receptor mechanism with the somewhat wider latitude of choice afforded by the Mediums, the receptor mechanism evidences irresolution. The importance of this to intelligibility is as yet undertermined. It follows that Minimum and Maximum but not Medium transems (magnitude families) exist as recognizable entities to listeners and therefore warrant consideration among the factors that are related to intelligibility.

No evidence was obtained to support the hypothesis based upon the assumption that recognition of greater magnitudes would be superior to recognition of smaller magnitudes. The Medium transitions, instead of providing values intermediate to the other two magnitudes, were not even recognized above the level of chance. This means

that the relationships of the three magnitudes is not a linear function, either positive or negative. Instead an "all or none" type of behavior with respect to the recognition of transition is suggested.

Although the Initials for both Minimum and Maximum transems were significantly better recognized than Finals, position for the Medium transeme category was not found to be significant. Thus, within the conditions of this study, the hypotheses concerning superiority of initial position were supported for Minimum and Maximum but not for Medium transeme.

Since the Medium magnitude was the most difficult to recognize, direction of transition shift might be considered as related to magnitude recognition. This did not seem reasonable in view of the design of this study since (1) recognition of Medium allotrans were correct independently of direction, (2) correct identification of Maximum allotrans required direction, (3) Minimum allotrans were correct only with absence of direction, and the possibilities for correctly identifying the Medium allotrans were double those of the other two transems with respect to direction. This means that on a chance basis alone, if direction of shift were a determining factor, the Medium transeme would have had an advantage. Since this was not the case, direction of transition shift was not indicated as a differential factor in transition magnitude recognition.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

The question of concern in this study was the assumption that magnitudes of interphonemic transitional influences could be differentially recognized and identified. Monosyllabic nonsense syllables were structured by combining consonants and vowels, with respect to hub location, to effect three discrete magnitudes of transition. CV, VC, and CVC syllable forms were employed to afford double representation of each combination within each list and equal representation as to location of transition with respect to the vowel. Six male speakers recorded the syllables which were presented to 24 trained listeners (syllable and speaker orders randomized) in progressively destructive S/N ratios. The +3 db S/N ratio responses were analyzed. The criterion measure was the number of correct responses for one listener for one transeme for one position irrespective of transition direction. Responses were pooled for the six speakers. An analysis of variance was employed to evaluate the data.

Conclusions

The conclusions suggested by the results of this study are as follows:

1. Transemes, or discrete magnitudes of interphonemic transitional influence, exist as entities with respect to listener responses and can be differentially recognized and identified.
2. Recognition cues do not appear to increase in importance with increased transition magnitude when direction of the transition shift is disregarded. Instead, the least transition shift afforded best recognition. Since the greatest magnitude was superior to the medium magnitude, neither a positive nor a negative linear function is indicated. Therefore, an "all or none" type of response behavior with respect to transition recognition is suggested.
3. Position of the transition influence is indicated as significant for minimum and maximum magnitudes with initial position significantly superior to final position.
4. In the perception of the three magnitudes studied, direction of transition shift is not indicated as being related to success of recognition.

In view of the results of this investigation, it follows that future efforts to delineate the code units of speech should not disregard interphonemic transitional influence. This attribute seems to deserve further consideration with respect to connected speech. Also, magnitude of transition occurring in words should be investigated to determine the possible relationship of this factor to articulation testing and speech intelligibility.

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APPENDIX A

Syllables employed
to effect transition magnitudes.

MINIMUM TRANSEME			MEDIUM TRANSEME			MAXIMUM TRANSEME		
<u>CV</u>	<u>VC</u>	<u>CVC</u>	<u>CV</u>	<u>VC</u>	<u>CVC</u>	<u>CV</u>	<u>VC</u>	<u>CVC</u>
tfi	itf	tfiz	ti	it	tiz	pi	ip	piv
dgi	idz	dgif	di	id	dis	bi	ib	bif
fi	if	fidz	si	is	siz	fi	if	fiv
gi	iz	gitf	zi	iz	zit	vi	iv	vip
pu	up	puf	tu	ut	tuz	tfu	utf	tfuz
bu	ub	buf	du	ud	dus	dgu	udg	dguv
fu	uf	fub	su	us	sud	fu	uf	fudg
vu	uv	vuf	zu	uz	zut	gu	ug	gutv

APPENDIX B

Criterion measures for
each transeme.

MINIMUM

SPEAKERS

Listen- ers	S-1		S-2		S-3		S-4		S-5		S-6	
	I	F	I	F	I	F	I	F	I	F	I	F
1.	15	13	15	11	15	13	16	16	16	15	16	11
2.	15	15	14	14	16	15	16	16	16	14	16	13
3.	14	14	14	14	16	14	16	16	16	14	13	15
4.	15	15	15	12	16	13	16	16	16	16	16	11
5.	12	13	13	11	15	13	14	12	15	14	14	10
6.	13	13	14	12	16	12	16	14	16	14	16	12
7.	14	12	15	14	16	14	16	16	14	16	15	13
8.	15	13	15	11	16	14	16	15	16	13	14	13
9.	15	14	15	14	16	13	16	16	16	15	15	11
10.	13	13	15	14	16	15	16	16	16	11	13	13
11.	13	13	15	14	14	12	15	16	15	16	11	13
12.	14	12	15	13	14	13	14	14	14	13	15	13
13.	13	14	15	14	16	13	16	16	16	16	15	13
14.	13	12	13	12	15	13	16	16	13	15	12	13
15.	14	14	15	13	15	13	16	16	16	14	15	14
16.	16	10	15	11	15	13	16	14	15	12	14	11
17.	11	15	14	12	14	12	16	16	14	16	13	13
18.	16	15	16	13	14	14	16	16	16	15	15	15
19.	13	12	14	11	16	12	16	16	16	14	16	15
20.	15	14	15	12	15	15	16	16	16	15	15	14
21.	12	13	13	12	14	15	16	16	16	12	15	10
22.	16	14	14	13	14	15	16	15	14	14	14	15
23.	14	13	14	12	15	14	16	16	15	15	14	12
24.	12	14	14	14	13	12	15	14	15	15	15	14

MEDIUM
SPEAKERS

Listen- ers	I	F	I	F	I	F	I	F	I	F	I	F
1.	7	8	13	13	11	11	9	10	12	12	9	10
2.	4	5	12	13	13	11	8	9	13	12	12	12
3.	9	7	12	15	14	13	14	11	14	11	13	12
4.	9	9	13	14	16	12	12	13	12	11	15	12
5.	2	4	12	11	12	11	8	13	10	11	7	11
6.	8	10	12	13	8	11	6	10	13	13	7	10
7.	10	10	13	15	13	14	13	16	10	13	13	13
8.	6	8	15	15	10	10	10	12	13	13	12	14
9.	8	10	14	14	14	14	13	12	13	11	13	14
10.	9	10	14	14	14	14	11	12	13	12	12	12
11.	5	9	14	15	11	13	10	9	12	13	10	11
12.	8	8	14	15	14	11	7	9	12	9	11	12
13.	8	8	13	12	11	13	11	9	9	12	9	11
14.	3	3	11	9	9	4	8	7	8	5	5	4
15.	14	10	12	12	15	9	12	12	15	12	11	7
16.	9	10	11	9	13	12	10	11	11	11	14	10
17.	8	11	14	12	11	12	14	12	15	14	10	9
18.	11	10	12	14	13	11	10	10	12	10	8	6
19.	9	11	14	16	13	13	12	11	13	11	14	15
20.	10	11	13	13	11	9	12	12	16	12	11	10
21.	11	10	15	12	10	10	13	14	14	13	11	12
22.	11	8	15	12	13	12	12	11	11	7	10	6
23.	7	12	14	13	11	10	8	11	14	10	11	10
24.	8	6	12	15	10	10	9	11	11	13	11	7

AUTOBIOGRAPHY

I, George James Harbold, was born in Indianapolis, Indiana, March 21, 1918. I received my secondary school education in the public schools of Lake Worth, Florida. My undergraduate training was obtained at the University of Florida, from which I received the degree Bachelor of Arts in Education in 1942. After almost four years of military service and one year of public school teaching, I returned to the University of Florida from which I received the degree Master of Arts in 1947. After teaching one year at Marshall College, Huntington, West Virginia, I attended the University of Missouri and taught there on a graduate assistantship. Full time teaching was resumed the following academic year, 1949-1950, at Central Michigan College of Education. In September, 1950 I returned to Marshall College from which I obtained a leave of absence the Summer of 1953 in order to attend The Ohio State University, where I specialized in Speech Science and was awarded an Audiology Fellowship for two years while completing the requirements for the degree Doctor of Philosophy.