DISTINCTIVE FEATURES IN MALAYALAM

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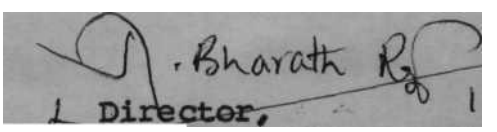
CERTIFICATE

This is to certyfy that the dissertation entitled "Distinctive Features in Malayalam" is the bonafide work done in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No. 2



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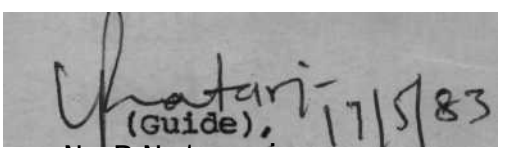

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DECLARATION

This dissertation entitled "Distinctive Features in Malayalam" is the result of my own study undertaken under the guidance of Mr. N.P. Nataraja, Lecturer in Speech pathology. All India institute of Speech and Hearing, and has not been submitted earlier at any university or institution for any other diploma or degree.

Register No

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Chapter I

INTRODUCTION

INTRODUCTION

"I find my position as an articulate mammal
bewildering and awesome
Would to God I were a tender apple blaussom"
- Ogden Nash

Human beings do really find themselves at times in most bewildering of positions when encountered with the delicate subtelties and intricasies of language?, of those permitations and combinations of sounds which are used so naturally emit.

Language is built of words, words of sounds or phonemes, and phonemes of features which are distinctive from each other. A explicitly simple sound is thus composed of several parameters which can be seen in the form of features which describe it. Those features which provide us with the information about the various distinctions between these speech sounds are called distinctive features. In essence the distinctive features can be thus referred to as'building blocks of the phoneme'. Speech specialists are interested not only in the combination of various featuressin the phoneme but also in the way each of these 'features'are acquired, maintained and lost during pathology.

Articulation disorders have a relatively new opened to them. Speech scientists have been regarding misarticulation as a form of 'distinctive feature deviation' (Singh, 1972). Distinctive feature approach is now being applied to speech pathology in the process; of diagnosis, testing and treatment aspects.

Various approaches have been reported about the study of these distinctive features. They are- 1) Acoustic method, 2. Articulatory method, 3. Using computer technology and 4. Perceptual method.

Acoustic method identifies features by the following acoustic clues, a) voice onset time, b) transection of Formant, c) concentration of energy, locus of energy and duration of energy. Articulatory method used phonetic description of the sounds to define distinguishing qualities of speech sounds (Chomsky and Halle 1968). The computer method involves developing a specific programme being given to the input for the features (Telage 1980), Elbert, Laman and Bruce, 1981). The perceptual method requires the study of the perceptual responses to the sounds by the listeners.

The establishment of feature system in a particular language can be done by either the apriori or a posteriori method. Miller and Nicely (1955) define the apriori

method as 'defining or proposing a system before the aBticulatory / acoustic or perceptual analysis is done. This method lacks flexibility but is less time consuming than the Aposteriori method. In the Aposteriori method, a large sample is taken which is analyzed by various techniques.

Various studies show that the concept of distinctive feature analysis is valuable in the management of articulation disorders. (Haas, 1963;; Weber, 1970; Compton, 1970; McReynolda: and Huston, 1971; Pollack and Pees, 1972;, McReynolds and Bennett, 1972; Singh and Frank, 1972, etc). Many investigators like Pollack and Rees 1972, state the multi faceted advantages of distinctive features and rank economy to be the most significant factor among them.

The horizons of the realm of speech perception have been broadened by the feature approach. The feature analysis as compared with the sound analysis provide multi-dimensional information about speech sound perception. Many studies have been done in the hard of hearing population regarding their perceptual abilities (Binnie, Montgomery, Jackson 1974; Danheim et al 1978; Doyle et al 1981; etc). Recently linguistic evidence has also been shown for some features, (ie. encoded features) are processed in the left hemisphere for the right handed

individuals, (studert, Kennedy and Shankweeler, 1970; Hayden et al 1979, etc).

NEED FOR THE PRESENT STUDY:

"Speech pathology deals with the understanding, assessment and treatment of speech and language disorders. This necessitates a good understanding of the case who has the problem; and in addition the language to be taught. The situation in India, with its multiplicity of linguistic groups, presents additional problems in that the speech clinician may have to work with languages non-native to him" (Somasundaram, 1972:).

This clearly necessitates the need for the distinctive feature analysis in different language and hence in Malayalam.

308 minimal pairs were made using the 38 phonemes of Malayalam and were randomly presented in quiet situation to 30 listeners who had their mother tongue as Malayalam, and another group of 30 listeners who had their mother tongue as Kannada. Their responses were recorded and perceptual analysis was done by the experimenter. Later confusion matrices were constructed for the 2 groups. Information content of each feature was found out.

Spectrographic analysis for 37 words and phonemes were done and acoustic characteristics were detected.

STATEMENT OF THE PROBLEM:

This study is carried out to explore the possible existence of distinctive feature system for consonants in Malayalam by the perceptual and acoustic methods respectively.

HYPOTHESES:

(1) Malayalam language has a distinctive feature system.

(2) It is possible to propose a distinctive feature system in Malayalam.

(3) Consonants in Malayalam are made up of the following features- Obstruent/nonobstruent, voiced/voceless, continuant/noncontinuant, Retracted/nonretracted, noncontinuant nasals, nasal/nonnasal. Retracted/ nonretracted noncontinuant/obstruent, back/nonback, Retracted / nonretracted nasals, Retroflex/nonretroflex lteral/nonlateral, coronal/noncoronal, palatal/nonpalatal.

(4) Information value carried by each feature varies.

(5) Each feature has a distinctive acoustic characteristic.

(6) No significant difference will be found in the listening performance of Malayalam and non-Malayalam speakers when words with minimal differences are presented in a quiet situation.

(7) There is no difference between the Malayalam and non-Malayalam listeners with respect to perception of nasal phonemes.

Limitations of the Present Study:-

1. Distinctive Feature system has been proposed only for consonants.
2. Only the experimenter served as the judge in the present study.
3. 30 listeners were used in each of the groups.
4. Apreori analysis has been used.

Definitions used in present Study:-

Malayalam Speaker:- He or she is one who has got their mother tongue as Malayalam.

Kannada Speaker:- He or she is one who has got their mother tongue as Kannada.

Distinctive feature:- it is defined as that distinctive characteristic or feature which distinguishes one phoneme from another in the respective language.

Details about the definition of each feature is given in Chapter III.

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Chapter II

REVIEW OF LITERATURE

Part 1

BASIC CONCEPTS RELATED TO DISTINCTIVE FEATURES

"Well; I've often seen a cat without A grin, thought Alice, but a grin without a cat! It's the most curious thing I ever saw in all my life"

- Lewis Carrol
(Alice in Wonderland)

..... a feature without its phoneme will seem as ridiculous!

'.

"Language is everywhere. It permeates our thoughts, Mediates our relations with others, and even creeps into our dreams. Most human knowledge and culture is stored and transmitted in language usage, which is so ubiquitous that we take it for granted, without it however, society as we know it would be impossible"(Langacker 1973)

A language is also characterized by a phonological system and every native word of the language represcribed by a sound sequence that meets the restrictions of the system. Speakers of a language are capable of stringing words together to form novel utterances that express our thoughts, thus in learning a language we have to learn a set of words, each of which has one meaning and also learn its pronounciation. in addition scientific rules governing the formation of sentences should also be learnt. Thus 3 aspects of linguistic structure can be used to describe a language that is, having a semantic system, a phonological system and a syntactic system. In speaking of the semantic system of a language the meanings of the words and how the speakers' conceptual experience is devided is taken under consideration. For example a linguistic distinction between colours designated by words "blue" and "green". In seme languages such as in Hopi(an American Indian language), distinction

is made between three states of water! It thus shows that depending on the linguistic constraints distinctions are made which may be extremely subtle.

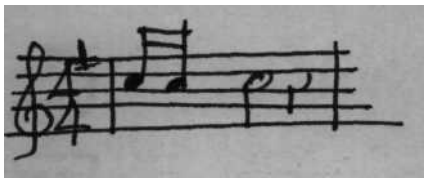
Just as there are constraints on the way sounds are combined to form words, so there are constraints on the way in which words can be combined to form sentences. As a process of learning, a person must master some set of principles that allow him to string words together to form acceptable sentences - the syntactic system or syntax of a language consists of these principles.

Thus a phoneme can be analyzed in terms of still smaller units, - the distinctive features. Now the concept that phoneme is the ultimate unit of language has changed that, it is considered that each phoneme is made up of a number of features which can be acoustically identified. These features are termed distinctive features, thus a phoneme can be analyzed. Chamber's Dictionary (1952) defines distinctive features as "—----- an element or prominent trait of anything, a characteristic." A pioneer in the field Sadanand Singh, (1976) describes the concept of distinctive features as the differences between two objects- A and B which can be represented as -

A	B	
Narrow	Broad	
Narrow +	Broad +	another refinement of the same.
Broad -	Narrow -	will be "long" and "short".

1.3

The concept of distinctive feature has been visualized very well by Bluemel(1978) as a chord in a musical score. Example



Haere the phoneme is likened to the whole bar consisting of form notes and the individual notes, the distinctive features of the particular phoneme. As heard in music, the phoneme is perceived by the listener as a single sound unit but can be further analyzed into its components namely, individual notes or distinctive features.

The cognition of distinctive features can be likened to that of recognition of faces in an alien place. For example, if a caucasean is exposed to a country where only the people from Mongolian race exist, initially tendency is there to see all faces alike, but after a while we learn to distinguish between them. Similarly in distinctive feature cognition also, the same is achieved after some time.

After discussing the concept of a distinctive features it is necessary to see how it is going to be represented. In the earlier example it was stated that the presence or absence of a feature being represented by + or - ; thus allowing only two possibilities. This is the binary system

principle wherein any aspect to be analyzed should be put either into the + ve feature or - ve feature division depending on the feature in question.

The neuro-muscular activity also follows the binary principle starting with the all or none law of the nerve fibres. Since there are only two states of a living nerve fibres - (1) that of activity or discharge and (2) that of rest and recharge, thus enabling all mental activity to be reduced to formulae of binary numbers, in the cybernetic processes of the central nervous system of association of ideas, conditioned reflexes, mathematical processes, analogical thinking and figures of speech to follow the binary principle thus assigning them to possitive or negative values and thus shunt them below or send them above to be processed at a higher level. West (1971) in his article "Neuro physiology of Speech" in the Handbook of Speech Pathology and Audiology" illustrated the binary principle as follows-——— "We polarize our reactions to many aspects of our environment, the room is either hot or cold; a movie good or bad . . . . such questions can thus be put in the binary question of + ve and - ve. West (1971) further explains the binary process.. . . . "If a word has both a synonym and an, antonym and utterance of that word well by free association call forth the antonym rather than the synonym- boy-girl.

rather than boy-lad; bad-good rather than bad-evil; yes-no rather than yes-OK."

The binary principle is used unconciously by one when one chooses a particular orientation of an answer to a question. For example when one is confronted with the problem namely - if 30 pears cost Rs. 3/-, how much do 6 pears cost? A child will actually have a lot of options for calculations, that is multiplication, addition, division and subtraction. But before any one method, he decides whether each of the options are correct or incorrat; in other words + or - , which is actually the application of the binary principle.

Using computer technology it is useful doing distinctive feature analysis of a language where each phoneme can be split up into its component features; which in turn can be assigned to a positive or negative value depending on the presence or absence of a particular feature. This will provide the most objective method of analysis of distinctive features.

Blache(1978) describes a feature system as a collection of properties that serve to seperate a collection of properties, that serve to seperate each element of a set of elements from all other elements. Various feature systems have been

described by schools such as Jacobson, Fant and nalle(1951) Miller and Nicely (1955), Chomsky and Halle (1968). Each of the distinctive features in them binary form will be represented in a graphical way by a distinctive feature matryx. It contains both elements and differential properties. By the use of the matrix, the phonologist can determine the type and number of sound property errors when an inappropriate phoneme is used instead of a target phoneme. The main purpose of the identity matrix is not merely didactic in intent but to identify each phoneme in a system along certain hypothetical levels. The use of the matrix has the power to transform a phonetic subject into a phonetic science. Using the matrix as a working base, it may be said that a matrix must eventually match the latent structure of the phoneme and the system simultaneously.

Part 2

DEFINITIONS OF DISTINCTIVE FEATURES

DEFINITIONS OF DISTINCTIVE FEATURES

According to Sadanand Singh 1976 "Distinctive features are the physical, (articulatory or acoustic) and psychological (perceptual) realities of a phoneme." By this definition it is meant that each phoneme can be defined and differentiated in terms of a) articulatory features namely place and manner of articulation and voicing: (b) acoustic features namely frequency, intensity and duration of speech sounds, (c) perceptual features. Gunner Fant (1973) defines it as "Distinctive features are really distinctive categories or classes within a linguistic system but just like in accepted phonemic analysis it is required that they are consistent with the phonetic facts and these phonetic facts on various levels have lent their name to the features."

Stephen Blache (1978) defines a distinctive feature as "As a distinctive feature system is a property that separates a subset of elements from a group." Jacobson (1962) talked about the distinctive feature in a very indirect manner in his letter to a Russian poet Xlebmkov. He suggested an analogy between the musical cords and the phoneme and the distinctive features. This model has the capasity to represent the phoneme as one unit - the chord itself, and the notes as the variety of components which are compairable to the features, a variety of motorically produced acoustic properties. A chord is heard

as one element and yet is made up of other elements. This transformation, a shift in emphasis from the unit to its sub-components was a consistant goal of distinctive feature theory. Fant (1973) also adds "A distinctive feature represents the linguist's condensed view of the minimal unit for composing speech message."

Parker (1974) defines the distinctive feature in a closed continuum referring to its binary characteristic of its mani-festation.as,-

"A distinctive feature of defines every point one and only one closed continuum".

Thus all these definitions of distinctive features clearly bring out their following characteristics-

- its physical nature (articulatory and acoustic as difined? by Singh (1976).
- its psychological component (as brought out by perceptual nature)- defined by Singh (1976).
- its binary property (as defined by Parker 1974).
- As being a part and parcel of every phoneme (as defined by Blache 1978).
- As having acoustic characteristics (as defined by Singh (1971

Sadanand Singh's definition of the destinctive feature seems to be the most Simple and comprehensive which takes into account all the facets of the distinctive feature namely, articulatory, acoustic and perceptual.

Part 3

ORIGINS OF DISTINCTIVE FEATURE THEORY

"It seems very pretty" Alice said, but its' rather hard to understand. You see, she didn't like to confess, even to herself that she couldn't make it out at all. Somehow it seems to fill my head with ideas, and I don't know exactly what they are!

- Lewis Carrol
(Through the looking Glass)

ORIGINS OF DISTINCTIVE FEATURE THEORY

PHONEMIC THEORY - According to this view there are two levels of phonological structure - an abstract phonemic level and a phonetic level that is roughly equivalent to the speech signal. Distinctive features are qualities contained in the speech signal itself that are necessary for the speaker-hearer to identify the phonemes of his language. This identification is made by picking out concurrent groups of these features and interpreting each group as a particular phoneme. If the phonemes of a language are made of distinctive features then the allophones of that language are made of distinctive and non-distinctive features. That is, within the phonemic theory, distinctive features, are taken to be all and only those features necessary to distinguish each phoneme in a given language from the other phonemes of the language. Eg: In English /p^h/ is the allophone of /p/. Since aspiration is not necessary to differentiate any two phonemes of English, it is not a distinctive feature, so then it must be a non-distinctive feature. Therefore with the distinctive feature as an element of a phoneme, the non-distinctive feature is also included.

Phonemes are significant abstract segments of a particular language. If one assumes that the distinctive features are the elements of phonemes, then this allows for the possibility of having language specific distinctive

features. The theory provides no means of preventing the practice of defining a separate set of features for each language. Because of this possibility, the phonemic theory does not provide a formal means of comparing the phonetic representation of two/more languages in terms of universal set of distinctive features.

The phonemic theory also postulates a certain relationship between the phonetic and phonemic level of representation.

(1) Every phoneme in the phonemic level can be represented by atleast one phone in the phonetic level.

(2) Phones at the phonetic level must be in the same order as the phonemes they correspond to at the phonemic level, However, at all levels there is no one to one relationship between the phonetic and phonemic levels of representation.

Phonemic theory of biuniqueness states that there must be an unique representation for each phonetic sequence and an unique phonetic representation for each phonemic sequence. Here the phonetic context is taken into consideration.

Some of the implications of the phonemic theory on the distinctive features are necessary to be considered?

(a) Phonemic theory implies the existence of nondistinctive features, which adds unnecessary formal apparatus to the theory and makes the concept of distinctive

feature very abstract and intangible.

(b) It allows the possibility of language specific distinctive features which makes comparisons between distinctive features of different languages impossible.

(c) It imposes the conditions of linearity and biuniqueness on relation between phonemic and phonetic levels of representation even though these conditions may not hold good.

Thus in conclusion it can be stated that there is a significant descrepency between the physical signal and the way it is perceived, it would seem that instead of directly interpreting the sound waves that stimulate the ear, the speaker hearer interprets them in terms of complex, abstract linguistic system that constitutes his knowledge of his language.

GENERATIVE THEORY - Discrepancy between the abstract linguistic system and physical speech signal led Chomsky and Halle (1968) to propose a different concept of phonology. It is derived from the phonemic theory in two ways.

Chomsky and Halle (1968) in their theory excluded the one to one relationship between phonological segments and speech segments with its conditions of linearity and biuniqueness. since there is no theory of phonemics

operating in generative phonology, it is based on a system of universal phonetics. Chomsky and Halle (1968) state that the features are identical with the set of phonetic properties that can be in principle controlled in speech, representing the phonetic capabilities of man and therefore the same for all languages. Limiting the distinctive features to phonetic properties that are independently controllable in speech makes the selection of distinctive features emphirical than arbitrary.

This theory defines the phonemes of a given language, because they are not directly observable they must be arrived by a discovery process, which are nothing more than alogirthms set up for this purpose. Enumeration of phonemes of a given language is a function of the alogirthm used to determine them, in the phonemic theory there is no way as to find out which of the two solutions for the phonemes is better? The generative theory obviates the problem by not insisting that each underlying form be associated apriori with a distinct set of phones.

Chomsky and Halle (1968) try to account for the type of phonological variation that exists between phonetics and abstract phonological forms. And they recognize two abstract levels of phonological structure - a more abstract classificatory matrix and a less abstract one, both in terms of distinctive features. A quality/parameter that is never significant in any natural language need not be

specified in the phonetic matrix. The classificatory and phonetic matrices of any given utterances may differ radically in terms of number of segments and the feature specification of each segment necessiates a method of transfering one into another. Chomsky and Halle (1968) propose an ordered set of context sensitive phonological rules that alter the feature specifications of the classificatory matrix to yield the phonetic matrix and viceversa.

O2o2o2o2o2o2o2ogo2o2o

Part 4

DISTINCTIVE FEATURE ANALYSIS

"Take care of the sense, and the sounds will take care of themselves" - The Duchess in Alice's Adventures in Wonderland, Chap.IX, Lewis carrol.

DISTINCTIVE FEATURE ANALYSIS: BY COMPUTER TECHNOLOGY

The latest trend in studying misarticulation has been towards describing the errors with the help of computer technology. Ideally distinctive feature analysis should be done at the beginning of therapy so as to monitor the effects of articulation training. The major draw-back here is the fact that the process is too laborious and not possible by most clinicians in schools (Albert, Lamar and Brace 1981). in order to provide a rapid, accurate and efficient method of computor analysis will be great help.

Telage (1980) did a study on the computerized place manner distinctive feature program for articulation analysis wherein the primary objective was to point out the patients articulatory behaviour that contributes maximum to misarticulation. Primary utility of the computerized analysis was to generate specific detailed information for developing individualized strategies for therapy.

Elbert, Lamar and Brace (1981) analyzed misarticulations using computer technology. The authors wanted a program wherein the clinician could enter the data directly from a video terminal to a computer. The computer program followed the steps of feature analysis given by McReynolds and Engmann (1973) based on feature system of Chomsky and Halle (1968) was used. The program written in FORTRAN was developed on a control data corporation 6600/cyber 172. It

requires 50,000 words and when data entry is complete, the program calculates 1) the number of times each feature was used correctly for the phoneme tested. 2) The plus and minus aspects of each of the thirteen features. 3) The percentage of times that the plus and minus aspects of a feature used incorrectly.

2. SPECTRO GRAPHIC ANALYSIS:

The visible speech Spectrographic techniques introduced by Bell Telephone lab about 15 years ago are still the most important means of the characteristics of speech waves. The most useful records are the well known spectrograms with time in horizontal direction, frequency in vertical directionand intensity of time frequency bounded areas displayed by the relative darknessor brightness. The overall intensity as a function of time has to be recorded by means of supplementary instrumentation to the spectrograph, in the form of an amplitude display curve on the same sheet as the spectrogram or as a seperate display on an oscillo-graph. Vowels and voiced sounds possess periodic or rather quasi periodic wave forms and accordingly display harmonic spectra. The fine structure arises as a result of the opening and closing movements of the vocal cords periodically modulating at a rate of Fo which is the fundamental frequency. In narrow band spectrograms Fo is the haSmonic spacing and in BEN spectrograms Fo is the time interval between successive

striations each reflecting a single voice cycle. The air cavities within the vocal tract act as a multi resonant filter on the transmitted sound and impress upon it a corresponding formant structure superimposed on the harmonic fine structure. Theae can be seen as Fl, F2 and F3 which are the main determinants of the phonetic quality of a vowel. They are conceptually contained in the term F-pattern more or less continuously across the often sharply time localized breaks in the spectrographic time - frequency-intensity picture. Each position of the articulatory organs has a specific F pattern. The time variation of the F pattern across one or several adjacent speech segments are refered as F - formant transition which are important cues for the identification of consonants.

Continous elements of speech are due to the continuity of the position of the articulators, discrete breaks being mainly due to shift in manner of production that is a change in active resonator system, etc. Spectrographic pictures might convey an overflow of data, binary coded pattern aspects as well as quantized parameter data belong to the inventory of such specifications. When processing the spectrographic data on connected speech the first object is to identify the boundaries of successive sound segments. A phoneme may be physically encoded into smaller or greater extent in the pattern aspect of several adjacent

sound segments. Eg- stops sounds are considered as made up of the occlusion, burst, the explosion transcient, a short fricative and a /h/ sound. Identification of a feature are based on the following parameters.

- Duration
- Intensity
- Energy
- Voice fundamental frequency (Fo)
- The F pattern (Fl, F2, F3, F4, etc)
- Formant structure (frequency intensity distribution)
- Fine structure - referring to speech production, the source (voiced , unvoiced).

3. MULTIDIMENSIONAL ANALYSIS:

In order to come to a true feature system that underlies all phonemes of a language, we have to have a hypothesis of a number of feature systems. Eg- Articulatory phonetic features, phonological features and acoustic features^. A statistical technique may be utilized to determine what features are truely realized in production and perception of sounds. These set of statistical techniques are called multi-dimensional analyaia.

TRUE PERCEPTUAL FEATURE SYSTEM:

1) The feature on a feature system must have articulatory and / or acoustic references.

2) Features in a feature system should be sufficient in number and specification to distinguish all consonants

with in a set.

3) The features of a set must be realistic in the sense that they can be utilized to predict with the maximal degree of probability the responses of the subjects perception of consonants. The problem with the phonologically based system is the fact that it may be same from the theoretical point of view but may be unable to account for speech production and perception errors.

An experimenter may use one of the following techniques to find out the similarity / dissimilarity between phonemes.

1. Absolute judgement.
2. Paired comparison.
3. comparison.

Multidimensional analysis tries to find out the following:

1. In what dimensional space or how many dimensions are the consonants or phonemes perceived?
2. Are these dimensions in nature and property similar to articulatory or acoustic features?
3. Do these dimensions contribute equally to perception or is there a hierarchy among them?
4. Do all judges use one dimension or do some judges use some and some others the rest?
5. Are these differences in individual ranking Singh, woods and Becker (1972) found that the Chomsky and Halle

(1968) system seemed to be the most real.

The consonants were perceived in 3, /4/5 dimensional scales. Singh, Woods and Becker (1972) gave a 5 dimensional solution which was-

Dimension 1- place of articulation front/back.

Dimension 2 - sibilancy.

Dimension 3- voicing.

Dimension 4- plosiveness.

Dimension 5- nasality.

The rank order from the most important to the least important dimension was 1. place of articulation, 2. nasality 3. sibilancy, 4. voicing, 5. plosiveness. Based on these principles a feature system called INDSCAL was developed by Singh, Woods and Becker. Voicing wee and nasality were identical to the other earlier feature systems. Place of articulation feature was similar with the Chomsky and Halle's feature anterior. The feature system evolved here is an outcome of the three data collection methods involving three groups of adult listeners and application of multi-dimensional analysis. The drawback of this system is that there is an artifact due to the considerable reliance on the statistical technique to tease out features of the perceptual or productive data involving the consonants. Secondly it does not contain enough number of features.

ARTICULATORY METHOD:

This method was used by Chomsky and Halle (1968). An universal set of phonological features was developed based on the phonological theory ofgenerative grammar. They described the articulatory features of universal sounds. The features are binary and are defined by adjectives. The vocal mechanism was considered in terms of source, areas of vocal tract involved, position of the tongue in relation to different areas and also oral and nasal cavity differences in terms of volume. Eg- The feature coronal/noncoronal is present in sounds which are produced by the blade of the tongue from raised neutral position. Chomsky and Halle (1968) believe that the features explained by this method provide a representation of an utterance which can be interpreted as a set of instructions to the physical articulatory system. Bernthal and Weever (1976) proposed a set of phonetic features. The features are related to articulatory characteristics of speech sound production. The features were intended to represent the essential articulatory characteristics and to provide means for abernant speech production.

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Part 5

DISTINCTIVE FEATURES FOR CONSONANTS - A REVIEW

DISTINCTIVE FEATURES FOR CONSONANTS - A REVIEW

(a) JACOBSON FANT & HALLE(1951): The body of work done by these pioneers was mostly on the acoustic aspect of the sounds using spectrograms which gives a three dimensional picture of the distinct pairs of consonants and vowels. After this they presented their articulatory basis of their acoustic finding and came to the conclusion that the distinctive feature was the ultimate unit because it cannot be resolved into any finer unit of distinction, in their system 12 distinctive features have been noted. (l)vocalic/ nonvocalic (2)Consonantal/nonconsonantal (3)Interrupted/ continuant (4)Checked/unchecked (5)strident vs mellow. (6)Voiced vs unvoiced (7)Compact vs diffuse (8)Grave vs acute (9)Flat vs plain (lO)Sharp vs plain (ll)Tense vs lax (12)Nasal vs oral. They also noticed that all languages did not contain all the features. They described the speech sounds in terms of presence/absence of a feature.

VOCALIC/NON VOCALIC: This feature is marked by the presence of the "Voice source" which can be represented on a spectrogram by clear formant characterstics. Nonvocalic ipplies the absence of these specifications.

CONSONANTAL/NONCONSONANTAL: This is the opposite of the vocalic non vocalic feature. Vocalic sounds are non consonantal and viceversa. This feature is considered as a fundamental source feature.

COMPACT/DIFFUSE: Here the basic difference lies on the terms of location of the energy. In compact sounds the energy is in the central frequency region and in diffuse sounds in the presence of one or more frequency concentrations in the noncentral frequency regions. This feature is a resonance feature because the compact consonants are produced in the posterior part (palate and velum). Diffuse sounds are produced in the anterior part (lips, tongue, and alveolar ridge) Compact consonants have less resonance behind the point of constriction in the oral cavity. Front and diffuse consonants have more resonance behind the point of constriction and less resonance in front.

GRAVE/Acute: This feature specifically relates to diffusedness which has energy concentration in the upper portion of the speech frequency region are considered acute. These sounds with energy concentration in the lower part of the frequency spectrum is called grave, (those diffuse sounds). This is a tonality feature because the difference here lies in the extreme frequencies.

NASAL/ORAL: Narrow band of energy is present at a very low frequency that is 200Hz and another at a relatively high frequency that is 2,5OOHz. This distinction is mainly possible of the supplemental resonator cavity that is the nasal cavity. Thisis labelled as supplemental resonator feature.

TENSE/LAX: Tense consonants have a longer duration than lax consonants. Additionally in stops, tense consonants have a greater strength of explosion than their lax counterparts. This is considered as a tonality feature, may be because of the fact that tense consonants have higher frequency components than their lax components.

CONTINUANT / INTERRUPTED: It is a secondary consonantal source feature which according to Jacobson, Fant and Halle consists of 2 types of features based on primary source that is envelope feature and the stridency feature. Continuant/ interrupted feature is considered an envelope feature because there is a smooth envelope of energy. (That is a smooth onset of energy for the continuants consonants and an abrupt one for the interrupted consonants). The term secondary consonantal feature implies the fact that the source of the sound is at the point of contact within the vocal tract itself. Articulatorally all fricatives are continuants and oral stops (affricates) are interrupted.

STRINDENT/MELLOW: Sounds with irregular or random distributions are considered strident and with relatively more regular waveform distribution are considered mellow. This is a secondary consonantal source feature.

MILLER AND NICELY (1955) They used a 5 feature system consisting of voicing, duration,affrtcation, place and nasality. They described consonants in four articulatory and one acoustic feature namely voicing,affrication,place, nasality and acoustic feature was duration. They did not leave any consonant unspecified in terms of either having or not having a feature. They assigned the numbers 1 to consonant having a feature sound and 0 to a consonant not having a feature. They first conceived of the confusion matrix where the stimuli is at the extreme left of the rows and sounds used as responses at the head of columns - the entries at the intersection of stimuli and responses represent the number of times the stimulus has been confused with the response. The basis of this feature system was the errors made by the listeners in identifying 16 different consonants, One major difference from the Jacobson, Fant and Halle's(1951) classification was the fact that Miller and Nicely adopted a ternary feature system namely place of articulation, and also instead of specifying the presence of a feature by + and absence by - , redundancy was indicated

by a blank. The feature systems proposed by Miller and Nicely was based on the perception studies.

(a) **Voicing:** Here the feature voicing is differentiated as voiced and voiceless by the vibration of the vocal cords. 1 is voiced and voicedless is 0.

(b) **Duration:** Miller and Nicely was the first to suggest the importance of this feature in perception. Fricatives have greater duration.

(c) Affrication: If the closure at the point of contact between the articulator and the point of articulation is complete the consonant may be stop/nasal - but if the point of contact is forced through a narrow aperture, the result is a terbulance or friction of noise.

PLACE OF ARTICULATION: The three different specification, present here are (1) Front, (2) Middle and (3) Back depending on where the constriction is. This may be an orbitrary assignment.

NASALITY: It is produced by opening the nasopharyngeal port and releasing intra oral pressure through the nose.

HALLE (1964): Halle designated plus or minus to each consonant, doing away with the idea of leaving a blank for

redundancy of features. The articulatory descriptions of the distinctive features became a prominent and sole basis of his feature system. Eight features were used by Halle (1964) namely.

VOCALIC - It referred to the periodic excitation of the vocal folds and the openness of the vocal tract to form the articulatory correlates of vocalic sounds. Non vocalic sounds are produced with no periodic excitation of the vocal folds and with a narrow opening of the vocal tract.

CONSONANTAL: This feature does not differentiate one consonant from the other. Consonantal sounds are those produced with occlusion or contact at the centre path of the oral cavity. Non consonantal sounds are produced without such occlusion. According to the degree of occlusion - maximum occlusion is for stops? sound degree of occlusion for fricatives; and third degree of occlusion for liquids and glides.

GRAVE: The definition of grave in this system was the same as that in Jacobson, Fant and Halle system.

DIFFUSE: This feature was designated only to consonants - compactness was designated solely to vowels. Here the consonants are considered diffuse and nondiffuse compared to compact vs diffuse as in Jacobson Fant and Halle's system

Diffuse sounds are produced in the anterior portion of the vocal tract and produced with utmost narrowing of the air passage in the vocal tract. Non diffuse consonants are produced at the posterior portion of the mouth with lesser degree of the narrowing of the air passage in the vocal tract.

STRIDENT: The strident consonants are produced by friction of the airstream across a sharp edge constriction in the vocal tract. Maximum emission of noise produced by the friction created by the airstream is emitted across the constriction.

NASAL: Nasal consonants are produced by the lowering of the velum thereby passing air through the nasal cavity, oral consonants produced by raising the raising of the velum.

CONTINUANT: They are produced by narrowing of the vocal tract in such a fashion that the narrowing phenomenon does not cause total occlusion. The noncontinuant sounds, are totally occluded at some point in the vocal tract.

VOICED: Voiced sounds involves the vibration of the vocal folds and voiceless does not no vibration of the vocal folds.

SINGH AND BLACK (1966) They extended the Miller & Nicely feature system by adding (1) Liquid to distinguish /b/ from /w/

and /g/ from /w/ and / j / .

(2) Retroflexion - to distinguish /r/ and /I/ .

(3) place feature to distinguish 1 from h. The other features are the same as those used by Miller and Nicely. The present feature system used 26 consonants of which 21 belonged to English and 5 others from three other languages from which speakers had been chosen for testing the linguistic familiarity of test consonants.

Voicing: 9 consonants /p,t,k,s, ,h,t, f , / are voiceless, and the remaining were voiced.

Nasality- Only /m/ and /n/ were nasal.

Frication.

PLACE OF ARTICULATION:- Here 4 places were specified-

(1) Front of the mouth (p, f, b, v, m).

(2) Mid-front of the mouth (t,d,s,z,, ,l,n)

(3) Mid-back of mouth (, , tj, d ,r)

(4) Back of the mouth (k,g,y)) It was not considered a binary but a multiple channel system consisting of 4 places having 4 channels.

(1) Labials/nonlabial (2)Alveolar/Nonalveolar (3)Palatal/nonpalatal

(4) Velar and nonvelar. It has shown to be efficient and valid (Singh 1966)

DURATION: 4 sounds were of longer duration. 17 sounds were shorter.

LIQUID: /I/ is a liquid - the other qere nonliquid. This system was extended by Singh(1968) to include all consonants of English. He added two new features namely glide - to distinguish between /w/ and / j / . The feature retroflex was used to distinguish /r/ from the consonants of English. This system is a complete feature system as it differentiates all 25 consonants of English from one another.

wickelgren(1966) He observed that when subjects were given to recall consecutive consonants the substituted consonants for the target consonant seem to be related and that they always differ by one or two distinctive features thus phoneme coding is taking place in the terms of distinctive feature. In his study he used the Jacobson, Fant and Halle system to analyze the phoneme codings. He then proposed his own set of distinctive features as a result of inspecting the cluster patterns of the matrices of consonant errors generated by the short term memory experiment. He specifically wanted to add same additional dimensions to handle laterals, semivowels and consonants. He retained (1) the Miller and Nicely's system of nasality and voicing features. (2)Made a finer distinction on the place continum from three to five. (3) A new approach to handle the manner of articulation. In this system, stops, fricatives, sonorants and vowels on a continum were possible. Stops were considered as having

the least degree of openess, fricatives having the second degree of openess. vowel like sounds having the third degree of openness. He adopted the binary feature for voicing and nasality and the ternary feature for openness and one feature with five specifications, if he had been a strict adherent of the binary feature then there would have been 10 features but would have been inaccurate because there would have been a great deal of overlap between features. Wickeolgren's introduction of the 5 specification of the place feature divided the 22 consonants into the following groups of place 0 /p, b, m, f, v, w/ place 1 (t, d, n, , r/ place 2 (s,z,)place 3 (,d , f, j/ place 4 (k,g, / openness was divided into 3 degrees - o in /p,b,m,t,d,n, , ,k,g/ 1 degree in /f,v, ,v/ 2 degree /w,r, ,j,h/.

CHOMSKY AND HALLE (1968): According to them phonological components from a system of rules that relate to the phonetic representation of the sounds of a language. They established distinctive features by examining different hierarchies of the linguistic rules. A sentence can be split into the following subdivisions ie. words in to phonemes? and phonemes into distinctive features, ie. it is broken down first by syntactic rules and then by phonemic sequencing rules and lastly by distinctive feature rules. They described the articulatory features of the universal sounds on the assumption

that the configuration of the human vocal mechanism and speech reception mechanism are identical in all human being. They wanted a system wherein all sounds of all languages could be described, each feature being binary in nature. The five major categories in the universal phonetic features of the Chomsky and Halle are (1) Major class features, (2) cavity features, (3) Manner of articulation features, (4) Source features and (5) Prosodic features.

MAJOR CLASS FEATURES: They consist of (1) true consonants (2) Vowels-vocalic, (3) Consonants that are more vowel like in nature (sonorant). According to Chomsky and Halle, during the closed phase the in-flow from the lungs is either impeded or stopped and pressure is built up in the vocal tract during the open phase air flows out freely.

CONSONANTAL / NON-CONSONANTAL: Consonantal sounds are produced with an obstruction in the vocal tract and non-consonantal sounds without such an obstruction. All vowels, glides are non-consonantal; because their production does not involve any obstruction in the mid saggital region of the vocal tract.

VOCALIC/NONVOCALIC: Vocalic sounds are produced only when the most radical constriction in the oral cavity does not exceed that in vowels / / and /u/ and when are positioned to produce spontaneous voicing.

SONORANT/NONSONORANT: Sonorants are produced with spontaneous voicing-nonsonorant sounds are those which do not involve spontaneous voicing. The vowels,glides,nasals and glides are sonorants.

CAVITY FEATURES: They are the second set of universal features described by Chomsky and Halle. They pointedout the difficulty in the IPA wherein they are described by two different systems. The vowels are described by the location of the 3 general areas - front,mid, and back and the consonants are described by the point constriction in the oral cavity - labial alveolar etc.

Jacobson's solution to these seperate systems for vowels and consonants was the presentation of two sets of binary features (1) Compact/diffuse (2)Grave/acute. The subclassifi-cations of these features are (l)Coronal (2)Anterior (3)Tongue body features (5)High low back (4)Round (5)Distributed.

CORONAL - NONCORONAL: Chomsky and Halle described coronal sounds as produced with the blade of the tongue raised from its neutral position and the noncoronal sounds as produced with

the blade of the tongue in the neutral position, Scevens 1901? Broach (1911) did not use this term when speaking of sounds formed with the flat part of the blade, in English r, 1, t, d, , , n, , z, , , are coronal; the remaining are non-coronal. All non-coronal are produced with the blade of the tongue in a neutral position.

ANTERIOR / NONANTERIOR: They are the other names for front / back features. All front sounds are anterior and all back sounds are non-anterior. This is on the basis that the oral cavity considered length wise with lips at the front end and velum at the back end. All consonants produced with constriction between the alveolar ridge and lips are called ANTERIOR and all consonants produced with the constriction between the palate and the velum called NONANTERIOR, sounds.

TONGUE BODY FEATURES: High, low, back relate to the position of the body of the tongue, all these projections are measured from its neutral position as in / /.

HIGH / NONHIGH: Sounds produced by raising the tongue body higher than its neutral position.

LOW / NONLOW: By positioning the tongue body lower than neutral positions - nonlow tithout such a lowering.

BACK / NONBACK: Moving the body of the tongue further back than its neutral position. Nonback where they are produced

without moving it from the neutral position.

ROUND: This is produced by the rounding of the lips to form oval / round variable shapes depending on the amount of rounding needed for the production of a given phoneme.

DISTRIBUTED/ NONDISTRIBUTED: It is the place of articulation feature not utilized in characterizing the sounds of English language. Distributed sounds are produced with a constriction that extends for a considerable distance along the direction of the airflow; Non distributed sounds are produced with constriction only for a short distance in this direction.

COVERED / NONCOVERED: The feature covered / non-covered is restricted only to vowels and found in some west African languages.

GLOTTAL CONSTRICTIONS: They are produced by the constriction of the glottal area beyond the neutral narrowing position.

SECONDARY APERTURE FEATURES: Nasal / Non-nasal, lateral / non lateral produced by lowering the midsection of the tongue.

MANNER OF ARTICULATION FEATURES

CONTINUANT / NONCONTINUANT: The continuant consonants are produced with the constriction in the vocal tract regulated in such as way that complete closure or blocking of the air-

passage never occurs. Non continuant (stops) are produced with complete closure so that the passage of air is blocked effectively.

RELEASE FEATURES: Two kinds of release features are described by Chomsky and Halle which apply to stop consonants, plosive stops are considered as released instantaneously; The affricate is a stop which is released with some delay.

TENSE / NONTENSE: Consonants which are voiceless are tense and voiceless are non-tense.

SOURCE FEATURES

VOICED / VOICELESS: Vocal cords vibrate for the voiced sounds; voiceless sounds are produced without vibration of vocal cords.

These features provide a representation of an utterance which can be interpreted as a set of instruction to the physical articulatory system or as a refined level of perceptual representation (Chomsky and Halle 1968).

	JACOBSON, FANT, HALLE (1951)	MILLER & NICELY (1955)	HALLE (1964)	SINGH & BLACK (1966)	WICKERLGREN	CHOMSKY & HALLE (1968)	INSCAL
(a) Definition of a phoneme	Acoustic			Percep-tual		Articula-tory	
(b) classifi-cation	Binary	Ternary	Binary	Binary	two-binary one-ternary one-with 5	Binary	Binary
(c) No. of features	12	5	8	7	Specifica-tions 4	5 major categories	5
(d) No. of consonants included	21 Consonants	16	18	21	22	All possible consonants	22
(e) Nasality	+	+	+	+	+	+	+
(f) Place of articula-tion	Back vs front	3 cate-gories front-mid-back	Absent	4 catego-ries	5 catego-ries		
(g) Vocalic	+	-	+	-	-	+	-
(h) Consonants	+	-	+	-	-	+	-
(i) Continuancy	+	-	+	-	+	+	-
(j) Openess	-	-	-	-	+	-	-
(k) Affrication	-	+	-	-	-	-	-
(1) Sonorant	-	-	-	-	-	+	-

	JACOBSON, FANT,HALLE (1951)	MILLER & NICELY (1955)	HALLE (1964)	SINGH & BLACK (1966)	WICKERLGREN	CHOMSKY & HALLE (1968)	INSCAL
stridency	+	-	+	-		+	-
Voicing	+	+	+	+	+	+	+
Duration	-	+		+		-	-
High/back	-	-	-	-	-	+	-
Liquid	-	-	+	+	+	-	-
Glide	-	-	-	-	+		-
Retroflex	-	-	-	-	+	-	-
Compact	+	-	-	-	-	+	-
Coronal	-	-	-	-	-	+	-
Sibilant	-	-	-	-	-	-	-
Low	-	-	-	-	-	+	-
Grave	+	-	+	-	-	-	-
Tense	+	-	-	-	-	+	-

Part 6

DISTINCTIVE FEATURES AND THEIR PERCEPTION

"The intellect pierces the form, overleaps the wall, detects intrinsic likeness between remote things and reduces all things to a few principles"

- Ralph Waldo Emerson
(intellect 1841)

DISTINCTIVE FEATURES AND THEIR PERCEPTION

The phonemes of a language are perceived in terms of distinctive features and thus supports the reality of the features. Miller and Nicely (1955) from a study showed that nasality and voicing show greater strength that is greater information transmission than the features duration, frication and place of articulation. When the speech is sent under low pass and high pass filter conditions, nasality, voicing and frication had higher rate of information, while under low pass conditions, features of place of articulation and duration, have a higher rate of information. The results of the Miller and Nicely (1955) experiment showed that the different features did not hold similar ranks in speech perception.

Rank order was, Nasality 62%, Voicing 59%, Duration 41%, Frication 40%, Place of articulation 27%.

Various studies where analysis of the perception of distinctive features were done are given below:

Singh and Black (1966) did a cross language experiment where listeners of Hindi, English, Arabic and Japanese spoke and identified identical set of 26 consonants in contexts of two vowels, purpose was to establish a common set of parameters or features across the four languages to investigate the universal application of a

selected group of consonant features in speech perception. Rank order obtained was (1) Nasality (2) place (3) Liquid (4) Voicing (5) Duration (6) Frication (7) Aspiration. By comparing the two studies, it can be seen that there is agreement between them.

Klatt (1968) did a study on the structure of confusions in short term memory between English consonants. There seems to be a natural dividing line between features that appear to be strongly present i.e., voiced, long frication, sonorant, continuant and strident and those present to a lesser degree (anterior - Coronal, nasal and consonantal).

Singh (197O) found a distinct difference between the English consonants perceived by English and Hindi speakers. For both the language groups affrication was one of the strongest features. Nasality and frication were one of the weaker features.

Wickerlgreen (1966) investigated the application of alternative distinctive feature system in predicting error in short term memory for consonants. The study indicated that intrusion errors in short term memory tend to have distinctive features in common with the presented consonants, but they are not remembered in an all or none manner. Some of the features of the consonant can be recalled, while others cannot? producing a systematic

tendency for the errors in short recall to have distinctive features in common with the correct consonant. This suggests that recall of a consonant means recall of a set of features that defines that consonant in memory, and each feature is recalled atleast semi-independantly of the other feature.

Ahmed and Agarwal (1969) investigated the information transmission in 29 consonants in Hindi at the initial position and final position in a CVC syllable. A feature system similar to Singh and Black (1966) was used to describe the Hindi consonants. The features nasality and aspiration demonstrated the most pronounced differences between their ranks both in initial and final positions.

Gupta, Agarwal, Ahmed (1969) determined the effect of clipping on the intelligibility of the consonants and features and to find out the amounts of information given by initial consonants and final consonants and to note differences in consonant perception for these two positions. Analysis revealed that the rank order of features in initial position was from most to least susceptible to clipping was place, nasality, liquids, and continuancy. In the final position of the syllable the greatest amount of clipping effect was seen for the feature nasality and smallest for affricates; maximum effect of clipping is seen for the feature frication.

Kennedy and Shankeveiler (1969) did a study on the hemisphere localization for speech perception. CVC syllables

were given in dichotic pairs. Results revealed that a significant right ear advantage was obtained for initial and final stop consonants, and for the features of voicing, and place of production in stop consonants. Analysis revealed that specialization of dominant hemisphere in speech perception is due to its possession of a linguistic device and not due to specialized capacities for auditory analysis.

Singh (1971) from a study hypothesized that
(1) The distinguishing characteristics of the voicing feature improved in noise and detereorated in quiet.
(2) Frication improved in quiet and deteriorated in noise.
(3) When in competition with other features in quiet condition, voicing feature was stable.
(4) Noise characteristics of frication were easily lost in the experimental noise.
(5) Nasals, liquids, glides were minimally affected by filtering and noise conditions.

Wang and Bilger (1973) found that nasality, voicing and roundness were perceptually important whenever they occured. Nasality was the best perceived feature in this study.

ROLE OF DISTINCTIVE FEATURES IN DICHOTIC PROCESSING OF A PHONEME

Cole and Scott (1972) found that the reaction time was greatest when pairs of syllables were most similar. Blumstein and Cooper (1972) found that the discrimination task was better when the consonants differed by more than one syllable. The feature differences in the identification task had to be scored in short term memory as well as be processed for discrimination, thus indicating that a loaded system and resulted in poorer scores.

Day and vigorito (1972) in a dichotic task reported that stops showed a right ear advantage while vowels showed a left ear advantage. This corroborated with the study by Studert-Kennedy and shankveiler (1970).

Blumstein, Tartler and Micheal (1973) investigated the perceptual reality of selected distinctive features in dichotic listening. The consonants were placed in CV context and only one or two feature contrasts were tested. Eg: /ba/ in one ear; /ma/ in the other ear. The overall identification of consonants was greater in the right ear. Fricatives and stops were identified significantly greater number of times in the right ear than in the left. Nasality did not show any difference between right and left ears.

Binne, Allen, Jackson (1974) did a study on the auditory and visual contributions to perception of consonants. Perceptual confusions for 16 consonant vowels were studied with normal hearing adults under various signal to noise ratios; auditory and visual only conditions. An articulatory feature classification wa* used to analyze responses with respect to percentage of correct identification and information transmission. In the auditory conditions voicing and nasality were least affected while place of articulation whowed greatest reduction in intelligibility. Auditory visual confusions indicated that the visual channel ia bisensory presentations reduced errors when phonemes differed by place of articulation' with greatest visual complement during the poorer signal-to-noise ratios, in visual only condition, the subjects were able to categorize phonemes into discrete homophonous group, part whole reliability for "Visual only" condition was high indicating it could be used with aural rehabilitation clients.

DISTINCTIVE FEATURE PERCEPTION IN HARD OF HEARING

Research has been done in this area by Danhauer and Singh (1975), Bilger (1976), Doyle, Danhauer, Edgerton (1980). The overall goal was to see what features are used by this population. Singh and Danhauer (1975) used different groups of Sensori-neural hearing loss subjects

and used filtered and unfiltered stimuli, conclusions from their studies seem to be the fact that filtering did not affect either the recovery of the features in any predictable fashion.

(2) Perceptual features of consonants were recovered by invoking "cues" not related to acoustic thresholds thus making possible for the subjects with sharp slopes in puretone sensitivity beyond 500 Hz to be able to utilize features of high frequency characteristics.

(3) The perceptual features obtained for these three groups of subjects were similar to the ones reported earlier under conditions of noise (Mitchell and Singh, 1974; Woods Becker and Singh, 1972). in a CVCV stimulus, the severely hard of hearing seem to process vowel information by their residual low frequency hearing (since hearing loss occur in high frequency areas) consonants are usually not perceived because they contain high frequencies and thus not perceived as blanks in the temporal continuum by the hard of hearing. Most of them can hear low frequency energy component of a voiced consonant.

Danhauer and Singh (1975) did a study in which cross linguistic responses were obtained to CVCV stimuli by severely hard of hearing children and profoundly deaf. The subjects were French, American and Yugoslavian. The perceptual features by them were nasality, voicing, sonorancy, sibilancy and continuancy. It was concluded

from this study that perceptual features of phonemes did not depend directly on the decoding of acoustic cues. Features were entities by themselves without direct correlations with acoustic properties of the stimuli and the auditory capacity of the perceiver.

Danhauer and Singh (1975) studied the feature-gram profiles of three different hearing impaired language groups using 7 distinctive feature consonant phonemes. The percentage of information value associated with the seven distinctive features for each group were plotted and ranked. A comparison of the featuregrams and pure tone thresholds showed the importance of the former in the realistic assessment of patients' hearing of speech sounds. Results indicated that the three hearing impaired groups derive greatest information from sonorancy, nasality, voicing and least by place and lability.

Bilger (1976) investigated the consonant confusions in patients with sensori-neural hearing loss, pattern of consonant confusions varied both with degree and configuration of the subject's loss. Different terms of feature identification was seen with different levels; subjects performing at the same level also did not show similar patterns of confusion. Findings agree with owen (1972) that high frequency hearing loss subjects had difficulty identifying sibilants. Owens (1972) did not find a relationship between confusion

Doyle, Danhauer, Edgerton (1980) studied the identification errors for intial consonants of CVCV of a nonsense syllable test were analyzed for normals and Sensori-neural hearing loss subjects. Listener's responses were recorded and transcribed and converted into confusion matrices and submitted to analyses of individual distinctive features. Results of analysis indicated that voicing, place of articulation, frication and sibilancy were salient features used by both listeners in the perception of consonants. That is, same perceptual strategies were used by both the groups. The only difference was that front/back relationship was retained for normals but not for sensori-neural loss cases.

Miller (1977) investigated the non-independance of feature processing in initial consonants. Mutual dependence in the processing of manner and place of articulation was investigated in two experiments

(1) the location of the voiced voiceless boundary as a function of place of articulation was done
(2) location of the bilabial-alveolar boundary as a function of manner class was also done.

in both the experiments, the location of the phonetic boundary systematically varied as a function of the non-target feature value. There is considerable evidence from a variety of experiments to suggest that feature information during perceptual processing, i.e., obtaining during

the perceptual processing.

Hayden, Kristen (1978) studied the role of distinctive features in dichotic presentation of English consonants. Results were evaluated for the entire stimulus set and various intra and inter manner class comparisons. Stops showed a greater right ear advantage.

Importance of distinctive feature in the accuracy of identification of phonemes are many

- the number of features contrasting between them affected the accuracy of identification.
- Significant number of error responses were blending or combining of features from the opposite ear.
- for each feature, one feature specification dominated over the other.

The difference between stops and other consonants may be due to that fact that acoustic cues for stops are briefer? the listener must separate the unattended consonant by ear and also identify the selective stimulus.

Gelfand and Silman (1979) found that information transfer under reverberation was poorest for place of articulation, stops, frication whereas sibilance, duration and semivowel information was barely affected. The effect of reverberation time was most in the final position, especially for place feature. Sibilants were found to be highly resistant to reverberation.

Arabie (1979) evaluated the role of acoustic properties in defining relationships between phonemes. INDSCAL model was used which provides a venue for the question of whether acoustic properties or phonetic features corresponds closely to perceptual dimensions. Results indicated that nasality and voicing are the features in the first dimension. This dimension had the largest perceptual effects in experimental conditions of masking and low pass filtering. With severe degradation only the first dimension was significant. A primary function of the second dimension is that of segregating the group of voiced consonants from the remaining. Phoneme projection on the third dimension do not clearly meet the criteria for features. Fourth dimension seems to specify perceptual information that is atleast as important for discrimination between consonants with the same values on the selected feature as between phonemes with contrasting values on that feature.

Results of the analysis supports the hypothesis that perceptual similarity appears to be heavily dependent on the acoustic props of the sound, observed patterns of similarity may not be consistently describably in terms of a single phonetic representation.

In conclusion it can be said that perceptual features appearing persistently and consistently were voicing, nasality, sibilancy, continuancy, sonorancy. They have potentials of being described simultaneously by selected

articulatory and acoustic factors. However, while the perceptual features might utilize the articulatory and acoustic properties, they are entities into themselves thereby superseding man's possibilities in both the auditory and articulatory domains. The recovery of high frequency features like place of articulation and sibilancy perceived by normal subjects and by severely hearing impaired young adults of several languages demonstrates the interdependance of features from close auditory ties. The hearing impaired subjects whose audiograms show appreciable hearing loss at and above 500 Hz have the ability to utilize these features in a complex perceptual task which cannot be explained by the theory of audition. Phonemic perception may defy auditory principles since it has been shown that listeners from various linguistic settings made perceptual errors with sophistication that was not a part of their phonetic repertoire.

Part 7

DISTINCTIVE FEATURES AND ARTICULATION

"They can't talk straight
Anymore than they can walk Straight
Their pronunciation is awful
And their grammar flawful"

— Ogden Nash
(It must be the milk)

DISTINCTIVE FEATURES AND ARTICULATION

"Articulation deviancy is mainly a disorder of distinctive feature misapplication in a particular phonetic environment" (Singh, 1976). Distinctive features are useful right from evaluation to therapy. The various studies of articulation from the point of view of distinctive features will be briefly reviewed here.

STUDIES:-

Haas (1963) studied the articulation of a dyslexic. Consonant substitutions of plosive, sibilant, nasal, liquid and place of articulation were deviant. Haas concluded that the important element in teaching sounds of speech was the discrimination of those features that the child fails to produce. He stressed the fact that a gradation of phonological distinctions be necessary.

Eibert, Shelton and ARDNT (1967) found that subjects who misarticulate /s/ generalized the rules to /z/ but not to /r/. This may be the fact because the feature differences are too many between /r/ and /s/.

CROCKER (1969) has stated that child's consonantal phonological competence is based on distinctive feature models. He stressed the orderly and systematic nature

of child's competence through out its emergence. He suggested that the child does not learn phonemes or features perse but by new rules for combining features and classes of features. "The model does not postulate that one sound is learned from another. It states that a feature is taken from an established feature sound and combined with another feature to establish a new feature set or sounds". (Crocker, 1969).

Crocker (1969) divided the chomsky and Halle's distinctive features into 3 categories, primary, secondary and cognate. Primary included vocalic, consonantal, nasal, strident. Secondary category included continuant, diffuse, voiced and grave. The cognate indicates the presence or absence of a feature.

A set is defined as the combination of features that make up a phoneme. He viewed that development is undifferentiated from general level to specific level. Normal and deviant articulation can be explained by this model. A sound may be misarticulated because of the complex combination of feature sounds required for its mastery. This may be because certain critical features were not mastered earlier in development or because the sound was confused with one whose features appeared earlier in a feature set.

Weber (197O) based treatment on two different principles

other than classical methods

(1) An entrire pattern/category was taught at once rather than one sound at a time

(2) Child was taught to consciously contrast the incorrect feature with correct feature throughout therapy.

COMPTON (1970) studied articulatory substitutions of two children and found that errors are systematic and that the substituted phonemes being the distinctive features.

McREYNOLDS AND HUSTON (1971) investigated whether a feature misarticulated in one phoneme was also misarticulated in other phonemes containing the feature* They also examined the hypothesis that a feature absent in the phoneme where it belongs may appear in the phoneme where it does not belong. The features used the greatest number of times were coronal, low, and consonantal? those used fewest number of times were stridency, voicing and continuancy.

POLLACK AND REES (1972) differentiated between phonetic errors and phonemic errors, phonetic errors were problems in auditory processing, motor sequencing. Phonemic errors are due to inadequate phonological development.

They felt that the following should be looked for while doing analysis using distinctive features.

(a) Is a specific feature totally absent from a set of features?

(b) Are all features present but not in combination with others?

(c) Are they present but inappropriately incorporated?

(d) Are features pertinent to a specific phoneme present in one phonetic context but absent in another?

Mc REYNOLDS AND BENNETT (1972) tested the generalization of features along phonemes. The features were first taught with the consonant at the initial position and then in the final position of the word. From their study, they saw the generalization on the sounds /f, v, s, z, /. They found that generalizations took place to a large extent and found this system highly economical and elegant.

OLLER (1973) studied the regularities in abnormal child phonology. Here generative notational conventions were applied to abnormal child speech which revealed a great delicacy in the substitutions of the child. All children showed some sort of fricative/affricate substitution. In early stages all fricatives and affricates are changed to cognate stops. All liquids were also changed into stops.

SINGH AND FRANK (1972) analyzed consonant articulatory problems in children who exhibited normal hearing and normal neurological development. Substitutions were counted in all three positions - initial, medial and final. Results indicated that no phoneme is immune to substitution, yet not all phonemes can be used as substitutes.

Manner Substitution - Stop replaced nasal and fricative but not viceversa. This is because stop or nasal is a feature of oral occlusion which is shared.

Place Substitution - It is substituted by the closest, more fronted place in the same manner as in the stop and nasal series. Alveolar was substituted for back and labial for alveolar.

Fricative Series - Alveolar was substituted for back, interdental for alveolar, labial for interdental.

Principles governing substitution rules is a combination of phonetic stability and interphonemtc similarity. A feature is considered stable if it substituted relatively infrequently. The earlier a feature is acquired the more stable it is and will replace the less stable features. An erred phoneme is more similar in terms of distinctive features. Conclusions based on this study were,

- The most recently acquired phonemes are replaced most often.

- Phonemes used as substitutes are most often the ones learnt earliest.
- stop feature is most frequent replacement for other manner features.
- fricatives and nasals are replaced by stops.
- stops are not replaced.
- Nasals and fricatives do not substitute for each other.
- A place feature is substituted by the closest more frontal place in the same manner of articulation.
- alveolar replaces back.
- interdental replaces alveolar.
- labial replaces alveolar.

OLLER AND KELLY (1974) studied the phonological substitution processes of a hard of hearing child. They found that all final fricatives and affricates were devoiced, fronting of consonants were seen, i.e., velar consonants replaced by alveolars. Dentalization and blading of alveolar consonants was seen.

KAMARA, KAMARA AND SINGH (1974) Articulation errors of 77 children were analyzed using distinctive features for both articulation. A feature gram was used to plot the subject's speech discrimination and or articulation scores, in terms of distinctive features. By analysing the discriminant analysis, the subjects fell into five groups namely (1) Pathology lesion

organic group. (2) Retarded group (3) cleft palate group (4) Functional group (5) Specific learning disability group. Each group had a significantly different profile.

KELLY AND KELLY AND SINGH (1973) They studied articulation problems of 60 children (8 - 10 years) 30 normal and 30 had articulation problems, it was found from the distinctive feature analysis that the Templine Darley test a unitary measure of the patient's articulation performance, the distinctive feature score being a measure of differential skill on the number of parameters reflecting the patient's underlying competence.

MARTIN AND RIYRODSKY (1974) investigated the phonological impairment in aphasia using distinctive feature analysis. A definite hierarchy for consonants was present with continuant occuring most frequently. Generally continuation error was similar to the phoneme in the stimulus. Degree of similarity as measured by distinctive feature spread between the phoneme subject to commutation and the other phonemes in the stimulus did not seem to be a major factor in a phoneme's tendency to get replaced by another phoneme. Strident, voice, coronal and continuant were the most frequently occuring oppositions. This hierarchy occured when the error phoneme was compared to the desired phoneme/stimulus phonemes and

not when the error phoneme was compared to other phonemes in the response. The problem was mainly thought not to be one of "programming movements" but related to perceptual memory and retrieval problems.

COSTELLO AND ONSTINE (1976) They analyzed the children's misarticulations in terms of distinctive features and selected a particular feature for remediation. During therapy sessions generalizations were apparent; 7 error phonemes by means of 3 error phonemes. This supports McReynold and Bennett's (1972) findings.

FERRIS (1978) analyzed deviant articulation in terms of distinctive features. The number of phoneme errors for each child was calculated. Phonetic errors were then transcribed into feature errors. Features were converted into percentages. It was found that young children made more feature errors than older children and that defective speakers progress in the same way as normal speakers.

METZ, CARD, SECTOR (1980) did a study on the remediation of voicing errors produced by hard of hearing adults using distinctive features. During therapy it was seen that stimulus generalization took place in /z/ but not to /v/ and / /. Thus one can hypothesize that subjects had not phonemically separated

/s/ from /z/y /f/ from /v/. subjects knew the rule but were unable to produce them. Results also indicated that voicing errors were not due to an aberrant feature rule but due to an instantiation of the rule in individual segments. Voicing errors are more phonetic in nature. They were unable to appropriately schedule the onset and offset of voicing in relation to supraglottal articulation of /v/ and / /.

RUDER (1981) used the distinctive feature approach to the patients who had phonetic disorders manifested by some definite problems in neuromuscular control of tongue movements.

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Part 8

STUDIESOF DISTINCTIVE FEATURES DONE IN INDIAN LANGUAGE

STUDIES OF DISTINCTIVE FEATURES DONE IN INDIAN LANGUAGES

Ahmed and Agarewal (1969) attempted to find the significant features in the perception of Hindi consonants* A quantitative procedure was adopted to ascertain which features were most significant for listeners and whether or not they are similar in initial and final positions. The amount of information transmitted in bits for stimulus was calculated for a given feature. Results indicated that-semi vowels and affricates were most intelligible and that major confusions existed among plosives, in both positions initial and final, confusions occured most frequently between consonant classes distinguished by a single feature; and they have concluded that in the initial position, confusions generally arise due to manner of articulation, and in the final position confusions in terms of place of articulation. They also found that initial and final vowel transitions play a very important part in recognition of consonants.

Gupta, Agrawal and Ahmed (1969) did another study on perception of Hindi consonants in 'clipped speech'. Effect of peak clipping on intelligibility of individual consonants was found and to correlate different information of initial consonants and final consonants and to see the difference in perception of the two positions. Results indicated that the average effect of clipping on features were as follows-

(1) place of articulation, (2) nasality, (3) flapped liquids, (4) liquids, (5) Continuants, (6) Voicing, (7) Frication, (8) Aspiration, (9) affrication.

Somasundaram.N. (1972) did a contrastive analysis of phonology of Tamil, Telegu, Kannada and Malayalam based on distinctive features. 11 distinctive features were necessary to distinguish the phonemes of the 4 languages. 1. vocalic, 2. consonantal, 3. nasal, 4. continuous, 5. tense, 6. Grave, 7. Compact, 8. Flat, 9. Sharp 10. Diffuse, 11. Strident. Based on the analysis it was found that Malayalam has; the maximum number of feature distinctions and maximum number of phonemes among the 4 languages. Features 1 to 8 are common to all languages. Number 11 is phonemic only in Tamil and Malayalam and 9 is phonemic only to Malayalam.

Somasundaram.N. states "since Malayalam possess all all the feature distinctions that are commonly available to all the languages, a native speaker of Malayalam will not find difficulty in identifying all the phonemes of the other three languages; But native speaker of Tamil or Kannada may fail to distinguish the dental and alveolar stops and nasals of Malayalam, because the sharp feature is only allophonic in those languages." He adds "A speech clinician whose native language is Malayalam may tend to over differentiate the sounds when he is to work with the

other three languages and under differentiation may be the case when a native speaker of Telegu, Tamil or kannada therapist tries to teach Malayalam."

Valentine (1977) proposed a system for classifying phonological segments into the following features-

(1) Back / nonback
(2) Nasal / nonnasal
(3) Obstruent / nonobstruent
(4) Continuant / noncontinuant
(5) Retracted / nonretracted
(6) Retroflex / nonretroflex
(7) Aspirate / nonaspirate
(8) Palatal / nonpalatal
(9) Retracted / nonretracted nonlateral nonobstruent
(10) Coronal / noncoronal
(110 Lateral / nonlateral
(12) Retracted / nonretracted nonconsonantal obstruent
(13) Voiced / voiceless.

Details of this system is given in the methodology.

Ramaswami.N. (1980) studied phonetic features of Tamil sounds. The features necessary to distinguish vowels are tongue features (high, low and back).

Features necessary to differentiate the consonants:

Stops, affricates and fricatives are non-sonorant or

or obstruents, stops and affricates are differentiated by fricatives by the feature continuant, stops are differentiated from affricates by feature (abrupt release) since the release of the arrested air in the caseof stops is abrupt but is delayed in the case of affricates. Point of articulation feature is also necessary. The feature anterior distinguishes sounds that are produced in fron of alveo-palatal region and those which are produced at the back of the alveo-palatal region.

Falguni Pathak (1982) studied the distinctive feature system in Gujarathi language using both articulatory and acoustic method. The following features were found to be present namely - Aspiration, Nasality, Semivowel, Retroflex, velar.

Venkatesh (1983) studied the distinctive feature system in Kannada language using both articulatory and acoustic methods. 8 features were found to be present, namely - Voicing, Nasality, Aspiration, Anterior, Coronal* Continuancy, Stridency and Lateral.

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Part 9

PROS AND CONS OF DISTINCTIVE FEATURE SYSTEMS

PROS AND CONS OF DISTINCTIVE FEATURE SYSTEMS

1. The most often quoted advantage of the distinctive feature theory is its economy (Pollack and Rees, 1971). Costello and Ostine (1976) modified the multiple articulation errors based on the theory of distinctive features. They used the Singh and Polen method by teaching the phoneme by sequentially adding features to phoneme already present in the repertoire. Results indicated that this tenhnique is highly efficient as 7 error phonemes were corrected by means of only 3 error phonemes. Results support the finding of McReynold and Bennett (1972). First the child is motorically learning to produce two phonemes in increasingly complex linguistic units and in a variety of phonetic contexts.

2. In conventional articulation therapy, each misarticulated sound must be worked with, in the distinctive feature approach an initial classification of the errors made are done so that it is easier to stress on a particular feature. The task does not look too formidable to the clinician because even though there may be many sounds which are misarticulated, in reality only a few features may need correction. This implies that by using the distinctive feature approach in therapy, time is saved.

3. This process of teaching the feature and its generalization has greater validity since by introducing the feature it is more central and stable than merely correcting a misarticulated sound.

4. During the assessment of the articulation disorder by using the distinctive feature,approach, by adopting the distinctive feature principle, the clinician can indicate speech therapy depending upon the general pattern of articulatory errors rather than upon a genetic developmental age level interpretation of when specific phonemes are mastered (Pollack and Rees, 1972).

5. A feature gram is prefered to the traditional speech discrimination or articulation tests (Danhauer and Singh, 1975). Processing of phonemes of hard of hearing and deaf cannot be predicted by pure tone audiograms which deals with specific frequencies. The speech discrimination does not present an interaction of the ear and the crucial properties of the speech sounds, phoneme perception is a function of distinct articulatory features of consonants and vowels. Plotting the patient's speech discrimination or articulation scores in the form of features; This by looking at the feature gram we can start therapy. Thus the feature gram is diagnostic, prognostic and therapeutic.

6. The use of the binary principle in the distinctive feature system enables the analysis to be done by a computer system.

7. Damien Martin and Regrodsky (1974) state that one of the advantages of the distinctive feature as "it serves both as a phonemic description and as an aid in,phonological analysis".

8. Distinctive feature analysis and therapy can be applied to any clinical population. In cases wherein definite neuromuscular control was lost, it was found that phonemic generalizations took place (Ruder, 1981). studies have been done wherein this system has been applied to the nature of phonological impairment in aphasia (Martin and Rigrodsky, 1974) and apraxics.

Any system has its own limitations; so has the distinctive feature system. Walsh (1974) in his article, "On certain practical inadequacies of the distinctive feature systems" critically evaluates the theory and presents its drawbacks. The essence of his critical view is as follows:

1. Main problem in the existing set of features is the fact that distinctive features arise from autonomous phonemics and transformational generative grammar (TGG) which have an idealized level of

language which is removed from the physical surface realities of speech. Jacobson, Fant and Halle (1952) proposed that all languages can be analyzed using these features.

2. Several of the features such as vocalic and consonantal, compact and grave are almost derived most entirely on acoustic properties and may appear in spectrographic analysis. Only flat and nasal (according to Walsh, 1974) appear to define a natural class of sounds.

3. According to McReynolds (1972) stiidency was found to be a major class feature because it can be generalized in other phonemic contexts, but this cannot be wholly accepted because they have presented no information, about the nature of the misarticulated sounds, manner, place, features present, obliterated, substituted.

4. Tense - lax feature can be considered a supplementary feature.

Leonard (1978) also discusses some inadequacies of the distinctive feature system. He notes that the (1) distinctive feature system serves two functions - an abstract classification and a phonetic classification. All the morphemes in a language are listed to

be in the phonetic aspect. At the abstract level a feature is allowed to have the values +/-. Here, there is no phonetic content directly associated with the features. According to Chomsky and Halle (1968), it is only in the phonetic function, the listeners receive a physical interpretation. At the abstract level, rules can apply which may modify values of certain features and assign a phonetic interpretation to them. Abstract level of distinctive feature should stop at a level* wherein a certain sound is taken into consideration for therapy. At this stage, it should stop because articulation therapy consists of giving phonetic rules.

(2) Adherence to binary view of features restricts one to 8 phonetically distinct front/back positions of articulation in describing the standard. It appears that the same phonetic production could be classified as one classificatory feature in one phonological system and another in another system.

Little information is present between segment and sound although an essential formal property of the Transformational Generative Grammar with its distinctive feature framework is to define a relation-ship (Wilson, 1966).

(3) The instructions given in therapy are also inde-pendant of the feature classification used. Postal(1968)

writes that the "classificatory level of distinctive features does not really think of the features relevant for the description of phonetic detail i.e., not considering them as the primitives of narrowest phonetic representation required to give pronunciation instruc-tion.

(4) Metz, Card, Sector (1980) did a study on the distinctive feature approach to remediation of voicing errors produced by hearing impaired adults. Feature analysis was applied to articulation errors produced by hearing impaired individuals. Results indicated that feature generalizations were less impressive and was seen that the subjects had not phonemically separated /s/ from /z/, /f/ from /v/. The subjects reported that they knew the rule but were unable to use it. The errors of voicing of these subjects were not related to an aberrant feature rule rather to the instantiation of the rule in individual segments. They, were unable to appropriately schedule the onset and offset of voicing in relation to their subglottal articulation of /v/ and / /.

(5) McReynold Engmann (1975) Sommer (1977) according to Metz, card, sector (1980) present an oversimplified account of the nature of articulation errors of hearing impaired cannot be characterized in terms of presence or absence of certain features.

(6) The analysis of the distinctive features is a very laborious and time consuming one. in order to make it more parisnomous in terms of time, a computer can be used, by this again cannot apply to all settings.

(7) Fant (1980) considers that there is no unique method to measure the duration of a phoneme and thus distinctive feature system has a major limiatation. He also feels that one of the weaker aspects of the distinctive feature theory is in the definition of consonants and vowels. Fant (1980) felt that liquids can be both and the classification of /h/ as non-consonantal and nonvocalic is arbitrary. Jacobson, Fant and Halle limit the consonantal feature to low intensity alone. Fant (198O) found that it was not so for Swedish vowels.

Fant (1960) also showed that the syllable contains a vocalic feature and it displays a temporal contrast with respect to adjacent sounds in terms of higher intensity or a more vowel like structure. Syllables should not be ascribed to intensity alone. Fant (1980) is also sceptical about the high over pressure for the tense feature and feels that the combined pressure for the same feature tense, had not been well documented in experimental work.

Malicot (1960) suggested that the combined effect of pressure and duration expressed as a pulsed integral could have a role in proprioceptive feedback, even though this may not hold good for English, the pressure factor present as an acoustical opposition between American English voiced and voiceless stops; a relatively small significance and secondary effect of glottal articulation is present. The longer duration and higher intensity of the noise interval following at the release of a voiceless stop is physiologically due to a delayed closing of the vocal cords compared with voiced stops. Pulmonary pressure appears to be the same in Swedish vowels and no difference in pulmonary activity comparing voiced and voceless consonants of short and long vowels was reported.

In essence, by weighing both the pros and cons of distinctive features, one can still warrant more of research in this area. A partial solution to the myraid of seemingly unrelated phonetic errors seemed to be solved to a clinician if he uses certain linguistic methods designed to determine patterns and regularities in phonology.

Thus the review of literature brings to light, the following facts about distinctive features namely.

- They can be used to study speech and language development in a child.
- To study the phonology of a particular language.
- To study factors which affect perception and production of speech.
- To study factors which affect speech communication in a particular context.
- To apply it to articulation therapy both at the level of assessment and therapy.

The number of studies done in Indian languages are limited and especially since India is a multilingual country, the clinician will need to understand in depth the phonology and distinctive characteristics of each language he deals with. The present study is thus an attempt to arrive at the distinctive features of Malayalam consonants, for a systematic and controlled method of dealing with speech and language pathology.

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Chapter

METHODOLOGY

M E T H O D O L O G Y

The present study was undertaken to establish a distinctive feature system for the consonants in Malayalam. Valentine,E. in his article "Features for classifying the underlying elements of phonological system of Malayalam" proposed the following criteria to classify the phonological segments of Malayalam.

Criteria for choosing the appropriate features to classify the phonological segments of Malayalam:-

The terms consonantal and non-consonantal are used to represent 2 major natural classes into which all Malayalam sounds segments are divided. Schave (1973) states "The feature (consonantal) refers to a narrowed constriction in the oral cavity either total occlusion or friction. Stops, fricatives, affricates, nasals, liquids are (+ consonantal), Vowels and semi-vowels without this degree of narrowing are (- consonantal). However in classifying the phonological units of Malayalam, it seems more appropriate to group the semi-vowels/approximants of Malayalam along with the consonantal segments for language specific reasons.

(1) The approximants (r, J T*) occur in consonantal positions in structure of Malayalam.

Eg- ava (they) (neuter-
aja (clothers line)

Wideband spectrograms were taken for each word using speech spectrograms(were by speech spectrograph VIC MK 700) The spectrograms thus obtained were analyzed to inspect the following characteristics.

- Voicing lag or voicing lead.
- Formant transition.
- Frequency at which concentration occurs.

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Chapter

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results of the two experiments conducted provides the information content for the phonemes of Malayalam, information content of features of Malayalam, information content of features and acoustic correlates.

The proposed distinctive feature was that suggested by (Valentine 1977).

(1) Back / nonback.
(2) Aspirated / Nonaspirated.
(3) Retracted / nonretracted non-lateral nonobstruent.
(4) Continuant / non-continuant.
(5) Coronal / noncoronal.
(6) Nasal / nonnasal.
(7) obstruent / nonobstruent.
(8) voiced / voiceless.
(9) Lateral / nonlateral.
(10) Retracted / nonretracted nasals.
(11) Retracted nonretracted noncontinuant obstruents.
(12) Palatal / nonpalatal.
(13) Retroflex / nonretroflex.

PERCEPTUAL ANALYSIS: The responses of 30 Malayalam and 30 non Malayalam speakers has been analyzed using a confusion matrix. A confusion matrix is one in which the stimuli and responses are portrayed. 38 phonemes were presented to 60 listeners as they occurred in 616 words, and represented

on vertical axis of the matrix as stimuli. The same phonemes as perceived by 60 listeners spoken at are recorded on the horizontal axis as the response. (See table 1, and table 2). Two confusion matrices were done one for each language group namely for 2 language groups. The number in each cell is the frequency of occurance of the sound is the response column for the sound shown in the response column for the sound shown in the corresponding column of the stimuli. The row gives the local frequency of the stimuli presented and the column gives the total frequency of the responses which occurred.

Further this confusion matrix for the phonemes of Malayalam was subdivided into voice communication network of 13 components binary channels of linguistic features based on the 13 features portrayed.

Eg-

Stimuli	Response	
	voiced	Voiceless
Voiced		
voiceless		

In all the confusion matrices thus formed the sum of numbers in the diagonal line indicates the number of correct responses and numbers scattered around the diagonal line indicates error.

A measure of covariance based on information theory (Shannon and Weaver 1963) was employed to calculate information transmission for a specific phoneme and for each feature was found.

Formula:

$$T(x,y) = -\sum_{ij} Pij \log_{(2)} \frac{Phix\ Pj}{Pij}$$

T (x,y) - information

transmission from input variable x to output variable y bits / stimulus.

ni = frequency of stimulus i

nj = frequency of response j

Pi = ni/N

pj = nij / N.

The results of the phonemic analysis are also presented in the Tables 6 and 7. Here information content carried by each phoneme feature using the same formula for information transfer based on information theory (Shannon and Weaver 1963). Here phonemic analysis was limited to the 60 listeners of both language groups and was limited to the speech sample taken. Results are presented in ranked order in Table 6 and Table 7.

1.	Back/non-back	0.9540531 bits/stimulus
2.	Nasal/non-nasal	0.612574 bits/ stimulus
3.	palatal/non-palatal	0.57044066 bits/stimulus
4.	Retracted/non-retracted, non-lateral. non-obstruent	0.55219818 bits/stimulus
5.	Retracted/non-retracted nasal	0.51435127 bits/stimulus
6.	Aspirate/non-aspirate	0.49947721 bits/stimulus
7.	Continuant/non-continuant	0.463187 bits/stimulus
8.	Voiced/Voiceless	0.42981683 bits/stimulus
9.	Caronal/non-coronal	0.39456872 bits/stimulus
10.	Obstruent/non-obstruent	0.37962598 bits/stimulus
11.	Lataral/non-lateral	0.360293 bits/stimulus
12.	Retracted/non-retracted. non consonantal/obsruent	0.35292969 bits/stimulus
13.	Retroflex/non-retroflex	0.3296284 bits/stimulus

Table 3: Table showing the ranking of features proposed by Valentine, 1977 for the Malayalam speakers.

1.	Retracted/non-retracted, non-obstruents	0.9929	bits/stimulus
2.	Back/non-back	0.98489	bits/stimulus
3.	Coronal/non-coronal	0.93449	bits/stimulus
4.	Voiced/Voiceless	0.760904	bits/stimulus
5.	Retroflex/non-retroflex	0.704669	bits/stimulus
6.	Retracted/non-retracted non-lateral/non-obstruents	0.44282	bits/stimulus
7.	Palatal/non-palatal	0.42650	bits/stimulus
8.	Retracted/non-retracted nasals	O.41642	bits/stimulus
9.	Nasal/non-nasal	0.3709865	bits/stimulus
10.	Lateral/non-lateral	0.334984	bits/stimulus
11.	Continuant/non-continuant	0.212034	bits/stimulus
12.	Aspirated/non-aspirated	0.44282	bits/stimulus
13.	Obstruent/non-obstruent	0.148143	bits/stimulus

Table 4: Table showing ranking of features proposed by Valentine (1977) for Kannada speakers.

Sl. No.	Feature	Language Group 1 (Malayalam)	Language Group Z (Kannada)
1.	Back/non-back	0.9540531 bits/stimulus	0.98489 bits/stimulus
2.	Nasal/non-nasal	0.612574 bits/stimulus	O.3709865 bits/stimulus
3.	Palatal/non-palatal	O.57044066bits/stimulus	0.42650 bits/stimulus
4.	Retracted/non-retracted non-lateral non obstruent	0.55219818bits/stimulus	0.9929 bits/stimulus
5.	Retracted/nonretracted nasal	O.51435127bits/stimulus	0.41642 bits/stimulus
6.	Aspirate/non-aspirate	O.49947721bits/stimulus	O.748143 bits/stimulus
7.	Continuant/non-continuant	0.463187 bits/stimulus	0.212034 bits/stimulus
8.	Voiced/Voiceless	0.42981683 bits/stimulus	O.760904 bits/stimulus
9.	Coronal/non-coronal	O.39456872 bits/stimulus	0.93449 bits/stimulus
10.	Obstruent/non-obstrMant	0.37962598 bits/stimulus	0.748143 bits/stimulus
11.	Lateral/non-lateral	0.360293 bits/stimulus	0.334984 bits/stimulus
12.	Retracted/non—retracted non consonantal/obstruent	0.35292969 bits/stimulus	0.9929 bits/stimulus
13.	Retroflex/non-retroflex	0.3296284 bits/stimulus	O.704669 bits/stimulus

Table 5: Comparison of the information content of the two groups (Kannada and Malayalam) of the features.

sl. No.	Phoneme	Information	Sl. No.	Phoneme	Information
1.	/k/	+2.018923	20.	/ /	+0.9639826
2.	/t/	+1.8214244	21.	/gh/	+0.9593396
3.	/d/	+1.8018147	22.	/ /	+0.9496943
4.	/P/	+1.7893997	23.	/ /	+0.7628007
5.	/c/	+1.6352528	24.	/t^h/	+0.7243562
6.	/m/	+1.6141874	25.	/d^h/	+0.6600672
7.	/kh/	+1.6137475	26.	/w/	+0.6600
8.	/n/	+1.5504621	27.	/l/	+0.6339562
9.	/s/	+1.4582572	28.	/ /	+0.5625502
10.	/ /	+1.4037825	28a	/n/	+0.565520
11.	/x/	+1.3823563	29.	/ /	+0.5500116
12.	/j/	+1.2186781	30.	/n/	+0.5495903
13.		+1.2082081	31.	/l/	+0.3929617
14.	ksha	+1.1957439	32.	/R/	+0.3881423
15.	/r/	+1.1742822	33.	/b^h/	+0.3842739
16.	/b/	+1.1669764	34.	/ ^{h}/	+0.2223851
17.	/n/	+1.1631853	35.	/ ha/	+0.1614512
18.	/l/	+1.0552	36.	/j^h/	+0.1173971
19.	/g/	+1.013468	37.	/P^h/	+0.0548962

Table 6: Results of the phonemic analysis for information transmission for Malayalam Speakers.

Sl. No	Phoneme	Information	Sl. No.	Phoneme	Information
1	/d/	+1.953404	20.	/g^h/	+0.5743231
2.	/k/	+1.3657368	21.	/ /	+0.544234
3.	/t/	+1.3412729	22.	/g/	+0.4838398
4.	/P/	+1.2534215	23.	/ /	+0.4296668
5.	/C^h/	+1.1406631	24.	/n/	+0.3745245
6.	/m/	+1.1049362	25.	/t^h/	+0.3435977
7.	/ /	+1.076909	26.	/ /	+0.3322
8.	/s/	+0.9629852	27.	/ /	+0.2952898
9.	/b^h/	+0.9170542	28.	/l/	+0.2650442
10.	/x/	+0.8876383	29.	/n/	+0.2522527
11.	/j/	+0.8187471	30.	/C^h/	+0.2426581
12.	/kh/	+0.8120623	31.	/k^h/	+0.2380737
13.	/w/	+0.7993225	32.	/dh/	+0.1593191
14.	/ /	+0.7816224	33.	/j^h/	+0.1415091
15.	/c/	+0.698086	34.	/t^h/	+0.1393187
16.	/n/	+0.697883	35.	/l/	+0.024778
17.	/ /	+0.6287587	36.	/R/	+0.00999317
18.	/t/	+0.593215	37.	/P^h/	+0.0042015
19.	/d^h/	+0.5853785	38.		+0.0032798

Table 7: Results of the phonemic analysis for information tramsmission for Non-Malayalam Speakers.

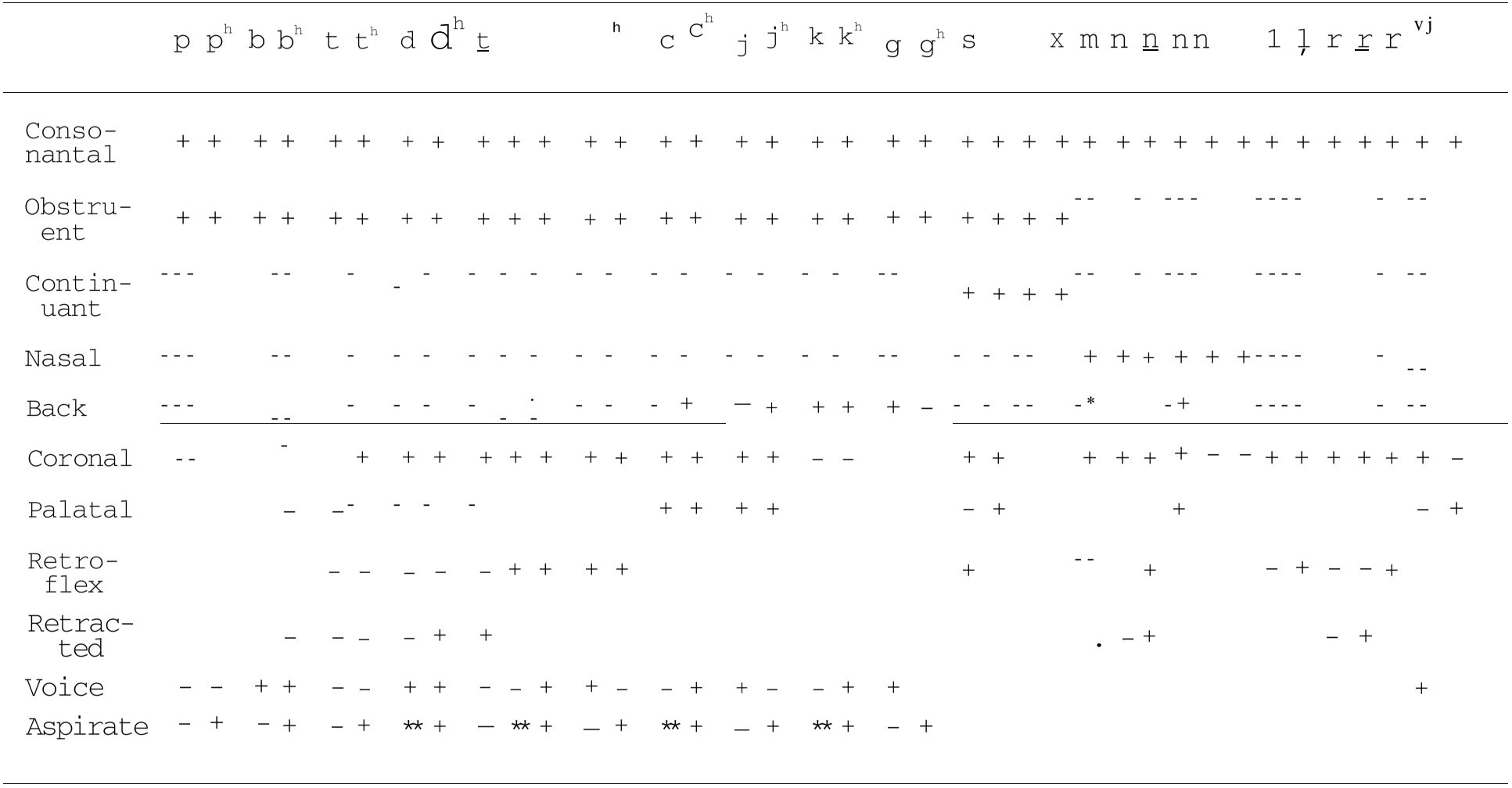


Table 8: Features for classifying the systematic phonemes of Malayalam (Valentine, 1977)

DISCUSSION:-

The non malayalam speakers, ie., the Kannada speaker's perceive the retracted and nonretracted noncontinuant obstruents maximally possibly because the phonemes present in them are also common in Kannada. Whereas in the Malayalam group this seem to be ranked only in the 12th position showing that Malayalam speakers do not perceive mainly using these phonemes.

Back/nonback: Both Kannada speakers and non Malayalam speakers seem to identify this feature and most of the phonemes are common to both languages.

Nasal/nonnasal:- The hypothesis, Somasundaram (1972) proposed, that Malayalam speakers are able to identify nasal phonemes better than other speakers has been partially tested here. This feature ranks second among Malayalam speakers and only ninth among Kannada speakers. This is a significant finding as Malayalam among the 4 south Indian languages has the maximum number of nasal phonemes thus enabling Malayalam speakers to perceive subtle differences among nasal phonemes over a Kannada speaker. Results of the phonemic analysis indicate that the information contained by /m/ seems to be the same rank both for both the groups of speakers.

Like the other consonantal sounds, the approximants also take an enunciative vowel in certain prepausal and precon positions.

kaav (a grove)

naaj (a dog).

Same frictional noise is heard in the articulation of approximants v, j, which is clearly audible when articulation is made with more than normal force, /v/ and /r/ have generate occurances parallel to those of other consonantal sounds. /c vv / - tuesday.

In Malayalam, the nonsyllabic glides do not become syllabic as a result of some phonological processes, (Valentine, 1977).

Schave (1973) states 3 requirements to be met by the appropriate features:- (1) They are capable of describing the systematic phonetics - a phonetic function. (2) At a more abstract level they serve to differentiate lexical items - a phoneneic function. (3) They define natural classes that is, these segments which as a group undergo similar phonological processes.

Based on these criteria classification system was proposed.

Classification of Consonantal segments;- Based on the behaviour of vocal tract during production-

Obstruent - Nonobstruent (Sonorants)

Sounds formed with more radical constriction than the glides ie. stops, fricatives and affricates are non-sonorants whereas vowels, glides, nasals and liquids are sonorants, (Chomsky and Halle 1968). Among Malayalam consonants plosives, affricates and fricatives are + obstruent and rest of the consonantal sounds ie. nasals, liquids and approximants form - obstruents.

(2) Continuant - non continuant (Chomsky and Halle (1968) distinguish Between the continuant and non-continuant thus "In the production of continuant sounds the primary constriction in the vocal tract is not narrowed to the point where the airflow past the constriction is blocked, in stops the airflow through the mouth is effectively Blocked". Among the obstruent segments in Malayalam, the fricatives form the continuant subset while fricatives and affricates form the non continuant subset. However in Malayalam the palato alveolar affricates may phonologically be marked (— continuant) ignoring the feature delayed release, as the plosives and affricates pattern like in the phonological structure of the language.

Nasal - Non nasal Chomsky and Halle (1968) gave the following articulatory descriptions for the nasals and nonnasals. "Nasal sounds are produced with a lowered

velum which allows air to escape from the nose. Non nasal sounds are produced with a raised velum so that the air from the lungs can escape only through the mouth." six significant nasals in Malayalam are identified, they are-

kammi - (deficit)
kanna- (cattle)
panni - (pig)
kanni - (virgin)
kanni - (mesh)
kanni - (rice gruel)
kanni - (hat at)

Coronal - Non coronal Chomsky and Halle describe the coronal sounds as those produced with the blade of the tongue from its neutral position? non coronal sounds are produced with the blade of the tongue in the neutral position, in Malayalam the class labelled, coronal consists of the 'dental' 'dentialveolar', alveolar retro—flex and palato-alveolar, are those produced by tongue from neutral position.

Lateral - Non lateral A lateral is a type of consonant segment produced By a structure of complete closure of the vocal tract so that there is lateral passage of the airstream, round the side/sides of the obstruction, (Abercoimbee, 1967). Malagalam has two lateral segments

which are functionally differentiated by the presence or absence of the feature of retroflexion, which differentiates /l̤/ from /l/. Both retroflex and the non-retroflex laterals can be double (ie. identical element clusters) or single. The non retracted /r/ is realized as a denti alveolar palatalized tap. Retracted /r̲/ is realized as an alveolar tap/ trill, / / is also retracted and realized as a retroflex slightly fricativized nonlateral sonorant which may with some justification be called an approximant. Though /^/ and A/ are non nasal nenlateral, the feature system evolves here a possibility of distinguishing them from the other nonnasal and nonlateral sonorants. Distinction between and is shown in words such as-

afa - grind

a/La - chop.

Functional differences between /r/ and / / and /r̲/ can be noticed by feature labelled 'retracted'. This feature is also found in certain other dravidian languages like Brahei, Kota and in some dialects of Tamil (Ramanujan and Vasica 1969).

Retroflex - nonretroflex "Retroflexion is defined articulatorily as a place of articulation feature in which the tip of the tongue is curled back and placed posterior to the alveolar ridge," (Stevens and Blumstein, 1975). Abercoimbee (1967) describes retroflexion as a displaced articulation.

In Malayalam consonants (+ retroflex) are there that are produced with the blade of the tongue and hence (+ coronal) but distinguished from the rest of the nonpalatal coronal segments by the action of the tongue which curls back (hence retroflexion) as a result of which the position of articulation is displaced from normal point of articulation for nonpalatal coronal sounds which is the area of the roof of the mouth covering dental and alveolar regions. This feature helps to mark off consonantal elements among (+ continuant) (- continuant) obstruents and also (+ nasal) segments and + lateral and (- lateral) coronal segments.

Back - nonback 'Back sounds are produced by retracting the body of the tongue from the neutral position, non-back sounds are produced without such a retraction from neutral position' (Chomsky and Halle, 1968). Back consonants are k, k , g, g ,x and velar nasal .

Palatal - nonpalatal Feature palatal is used by specify these consonantal segments which have the hard palate as the passive articulator- /c/ /c / / j / /j / /// are produced by blade of tongue in the palate-alveolar region. In Malayalam the palatal approximant is not a palato-alveolar consonant. It is palatal, articulated by raising the centre of the tongue towards the hard palate and hence described as centro-palatal.

Retracted / Nonretracted Among the nonpalatal coronal segments, the nonretroflex articulations form two subsets whose phonetic realizations have been traditionally classified under the labels "dental" and "alveolar". The former involves retraction of the blade of the tongue resulting in alveolar articulation. The latter in addition, is accompanied by curling of the tongue. Among the (- continuant) consonants of Malayalam, the alveolar plosive /t/ is assigned the feature (+ retracted) while dental plosive /t/ may be specified as (- retracted).

Retracted and Non retracted nasala The distinction between 'dental' and 'alveolar' nasals in Malayalam was pointed out. Native speakers based on make a distinction between /n/ and /n/ ie. dental and alveolar nasals.

Retracted and nonretracted non continuant obstruents- The feature retracted is needed also to differentiate the "alveolar" plosives of Malayalam from the dental or denti-alveolar ones.

mutti + /i/ (mut:i) matured.

/ente/ /en̪ e/ In Malayalam the following are classified under this feature viz. t, t̪, r, r̪.

Retracted and nonretracted nonlateral nonobstruents The nonlateral, nonretroflex, nonobstruents /r/ and /r̪/ need to be distinguished as they contrast in intervocalic

position as in

(uraňň) scraped.

(U̲raňň) to become settled.

Ladeflaged (1971) writes "Malayalam is the only language, I have investigated which (in some dialects) makes a distinction between two trills in the area, one being more dental and the other more alveolar. . . . The two trills contrast with two lateral and with a retroflex approximant."

Aspirated - Nonaspirated "The existence of numerous Sanskrit loan words in Malayalam and their use in every day speech even by non educated speakers necessitate the posting of a feature labelled phonologically as aspirate in order to distinguish words such as-

/koticc/ /kodit: / longed

/kat^icc/ /kat^{h}iti / stated.

and/p^{h}alam/ result.

/pata/ - foam (Valentine 1977)

This class includes p̪, b̪^{h}, c̪, j̪^{h}, ṯ, ḏ^{h}, ṭ, ḍ^{h}.

Voiced and Nonvoiced- Any segment of a language which is produced while the glottis is in vibration (Abercoimbee, 1967) and Nonvoiced is produced by glottis in open state.

STIMULUS:

308 minimal pairs in Malayalam were constructed using Gundert's Mikhander in Malayalam (1962). Word pairs were made to meet the following criteria-

(1) only the consonant in question would differ between the two words which may occur in initial, medial or final position, but as far as possible in initial position.

(2) Atleast to have a difference of one feature between the two consonants under consideration.

(3) it was attempted as far as possible to have the most familiar words. Each word occured in contrast with other consonants.

RECORDING:

The recording of the minimal pairs were done in a quiet room using a cosmic deck tape recorder model (The VU meter of the tape recorder was used to monitor the intensity. Between each word within the pair, a gap of approximately 7 seconds was given and between the pairs a gap of approximately 5 seconds so as to facilitate the subject's response.

SPEAKER:

A male native speaker of Malayalam served as the speaker for the recording of the minimal pairs list.

PROCEDURE:

The experiment was done in two stages-

Stage I:- Perceptual analysis.

Stage II:- Spectrographic analysis.

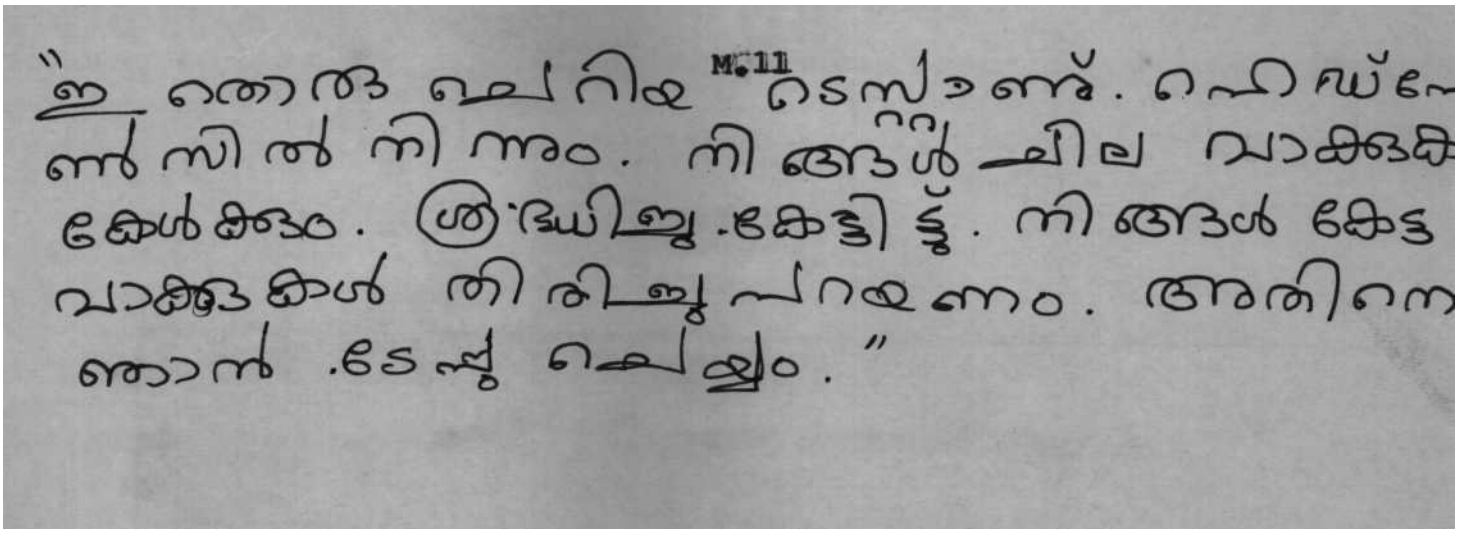
PERCEPTUAL ANALYSIS:

Subjects:- A total of 60 subjects participated in the study of which 30 had kannada as their mother tongue and 30 had Malayalam as their mother tongue. In each group there were 15 males and 15 females. The age range in the Malayalam group was 19 to 39 years and 17 to 44 years in the kannada group. Data relating to other languages known and exposure of the mother tongue were collected from each subject, in the kannada group, none of the subjects had any exposure to Malayalam. None of the subjects had any speech and hearing problem and were considered as normal by the experimenter.

INSTRUCTIONS:

Each of the subjects were given the following instructions:-

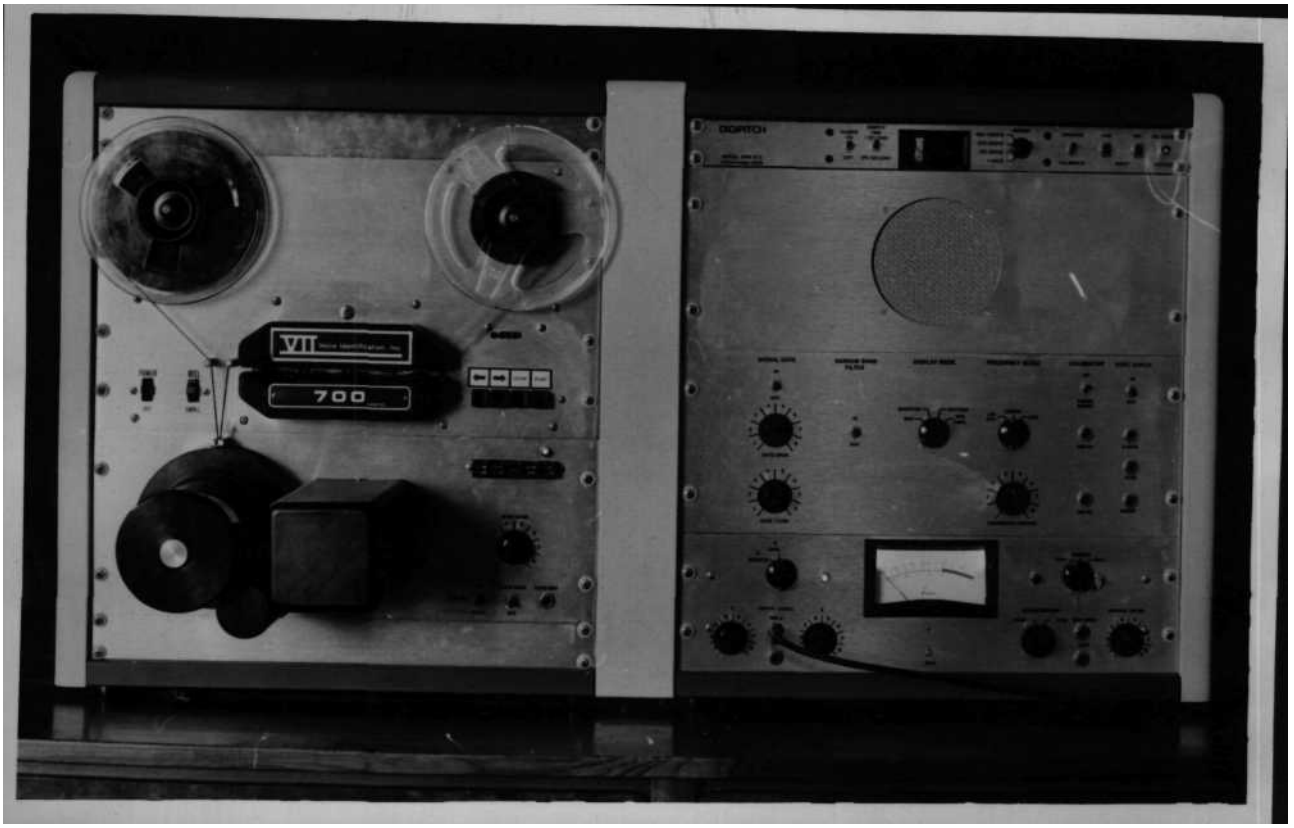
"This is a small test which I am going to administer. You will now be hearing words and you must try to listen carefully and repeat them. Your responses will be tape-recorded."



The 308 minimal pairs were randomized and presented individually to the subjects. The subjects were seated comfortably in a chair and the list was presented through the head-phones of the cosmic Deck Tape recorder No.( ) The responses given by the subjects were taped using National Panasonic tape recorder Model . The recorded responses were analyzed later by the experimenter. Eg. for if (balam / jalam) is said then the experimenter who served as the judge wrote it as / . Only the experimenter was used as(/b) a judge in the present study.

SPECTROGRAPHIC ANALYSIS:

37 words from the list were selected so that every phoneme was represented and could be contrasted with the other for the study of acoustic features.


VII
700
DORTCH

Palatal and Non-palatal

Even though both the languages Kannada and Malyalam have the sounds, they seem to have a higher place in the Malayalam speakers, in the phonemic analysis, it is again seen that both the speakers place approximately the same information content from the feature paiatal/nonpalatal.

Retracted/nonretracted nonlateral nonobstruent

There is a significant difference with regard to this feature in the perception in the two language groups, /r/ phoneme is unique only to Malayalam and as this sound is absent in the repertoire of Kannada speakers, thus making them less efficient in identifying this phoneme. The minimal pair /kar/ /KaR/ has been identified very poorly by the non-malayalam speakers.

Retracted/honretracted nasals

There significant difference between the two groups with respect to this feature also; as the alveolar nasal /n/ which occurs only in medial and final positions and are identified to a greater extent by the Malayalam speakers, /n/ is common to both Kannada and Malayalam and so identification of this phoneme alone may not differentiate the two groups but this feature enables us to show clearly the differences between two groups

in perception of retracted and non-retracted nasals.

Aspirate/Non-aspirate

This feature also is ranked differently by the Kannada and Malayalam speakers and the results of the phonemic analysis have a surprising finding that information content of aspirated sounds such as /b^h/, /^{h}/ /^{h}/ /d^h/ /p^h/ is least. Kannada speakers have ranked this feature 12th and in their groups the phonemiccanalysis and the feature analysis tally since both are ranked very low in information content. The possible explanation that can be given here is the fact that even though the Malayalam speakers rank phonemically sounds that are aspirated very low, when these sounds are placed in a contextual sequence as in a meaning word, they may be identified better because of the phoneme that follow it or precede it in the word and the features they contain.

Mallikarjuna (1974) found that the native speakers of Kannada who are not exposed to Sanskrit language are not able to make out the differences between Mahapranas and alpapranas in recognising and in reporducing the same. Socioeconomic status and caste do not play a significant role in the awareness of mahapranas. Spectrographic studies indicated that mahapranas(aspirates),

alpapranas (unaspirates) and alpaprana (unaspirates) plus /h/ are different. Acoustically alpaprana plus /h/ cannot be treated as a mahaprana and a mahaprana could be treated as a unit phoneme and not as composed of alpaprana plus /h/. Thus the aspirates as a unit phonemes support Nayak's(1967) stand and contradict Bright's(1966) point of view that since there is no phonemic contrast of aspirated consonant and consonant plus /h/, there seemed to be no reason to set up additional aspirate phonemes.

Continuant/non-continuant

There is a difference with respect to ranking of this feature also with regard to the two groups. Phonemic analysis results however for the two groups do not coincide with these results because the information content of the individual phonemes in this feature seem to be scattered. Valentine (1977) also states that the duration of malayalam sounds seem to be more? and may be a partial explanation for this finding since continuants have a longer duration than other phonemes.

(8) Voced/Voiceless

Kannada speakers have identified this distinction of voiced and voiceless at a much higher rank than Malayalam

speakers. in Malayalam coloquially, some of the voiced sounds get devoiced like . This lapsing of voiced into voiceless may be taken as a tentative explanation for ranking of this feature low among Malayalam speakers, in Kannada, on the other hand no such devoicing may be permissible thus making Kannada speakers rank this feature higher.

(9) Coronal/Non-coronal

Kanndda speakers and Malayalam speakers perceive differently this feature - the Kannada group ranking them much higher than the Malayalam group. This finding is supplemented by the fact that the feature retroflex/ nonretroflex feature is also identified by Kannada speakers; thus making them superior in identifying these phonemes for which the blade/body of the tongue has to be raised.

(10) pbstruent/non-obstruuent

Both the groups rank this feature to be quite low. That is, both the groups do not identify the plosives affricates and fricatives grouped and nasals, liquids approximants differently.

(11) Lateral/Non-lateral

This is ranked low among the Malayalam speakers

approximately the same among the Kannada groups. Both the groups have in their repertoire the phonemes and these are supplemented by the results of the phonemic analysis which indicate approximately the same information values of the lateral sounds in both the language groups.

(12) Retracted/nonretracted nonobstruent/obstruent

There is a great difference between the ranking of the 2 groups; the Kannada speakers ranking them highest and the Malayalam speakers very low because of the possible fact that Malayalam speakers perceive poorly all these features for which the body of the tongue has to be raised as in coronal/noncoronal and in retroflex/ nonretroflex.

(13) Retroflex/Nonretroflex

These rank the lowest among the Malayalam speakers and rank high among the Kannada speakers. The explanation tenable here again seems to be same where that Malayalam speakers are enable to perceive retroflexion as Kannada speakers, which are also supplemented by the finding that coronal/noncoronal feature is also poorly perceived by Malayalam speakers.

Thus the findings of the present study support the

Motion Theory of speech perception(liberman) since the non Malayalam speakers do not perceive certain phonemes such as /n/and n are since they are infrequently used their language if used at all.

ACOUSTIC ANALYSIS

Voicing: This feature has been characterized by presence of low frequency energy termed 'buzz' (Jacobson, Fant, Halle, 1969) in the voiced sound and absence of this in voiceless sound. The presence of this characteristic is marked by voice bars along the base of the spectro-gram which are identifiable as vertical striations.
(2) voice onset time is identified as voice lead in voiced sounds and voice lag in voiceless sounds.
(3) The energy concentration in the noise component of the spectrum either in stop or fricative sound is greater in voiceless than in voiced.

The acoustic characteristics which can be seen are
(t) Regular vertical striations in low frequency region which occurs simultaneously with the burst (stops or frication) indicating voice lead.
(2) Decreased intensity of burst when compared to its voiceless counterpart. These characteristics were observed in the consonants of Malayalam. Ex: balam palam., /p/, /b/, /k/, /g/. Spectrograms of these are appended.

Nasality - Acoustic characteristics seen here are low nasal formant at around 200 Hz and a tail like appearence.

- Little high frequency has been noted (Jacobson, Fant, Halle, 1969; Potter, 1966; Fry, 1979).

Minimal pairs such as were used to analyze the differences and also in isolated phonemes of /m/ as contrasted with /p/, /b/ non-nasal.

Low frequency formant and a tail like appearence were present for all nasal consonants. The nasal phonemes had these characteristics very distinctly in Malayalam. Presence of high frequency concentration at 2.5 KHz is also seen, in Malayalam therefore, these may be features for identifying nasality.

(1) Presence of low frequency formant

(2) Tail like appearenoe.

These were seen in the nasal sounds of Malayalam consonants, Eg: Nasal - m, n, n, n, Non-nasal - /p/, /b/.

Aspiration: This feature is distinctive to Malayalam because it can differentiate two sounds of the language and therefore can be considered as a separate feature. A comparison of spectrograms of the words containing aspirated and non-aspirated, it can be seen that, the acoustic cue for this feature is the fact that there is

the presence of aperiodic noise in the higher frequencies. This distinction was seen in phonemes of the language also.

Therefore in Malayalam, the presence of feature aspiration is marked by extra energy concentration in higher frequencies. Eg: /k/ different from /k^h/
/p/ contrasted with /ph/

Lateral: Jacobson, Fant and Halle (1969) state that lateral sounds are associated with vowel like and consonant like characteristics. The continuous bars in them are representative of vowels and the gaps are characteristic of the consonant parts.

Examination of words containing lateral sounds and examination of the isolated phonemes show the presence of the following features viz., presence of small gaps as shown in the spectrograph. Eg: /I/* /r/. /I/ contrasted with /n/.

Retroflex: This articulatory feature can be acoustically identified by the presence of relatively low frequency energy concentration and upward transition. This feature difference can be seen in the following minimal pair

/kari KaRi/

Continuant/non-continuant:

The acoustic characteristics seen for the continuant sounds like /s/ / s / / / are (1) high frequency turbulance of longer duration, greater intensity which is identifiable on the spectrogram, in /sh/ sound, the aperiodic noise component present in about 3.5 KHz-6 KHz region. Eg: in and isolated phonation of /s/ and /s/, etc.

Obstruent/Non-obstruent: The acoustic characteristics of this feature can be seen in the spectrograms /s/ and /s/

in /s/ filtor is seen at around 4 KHz.

Back and palatal: It is not possible to differentiate back and nonback as these sounds vary only terms of duration of VCT as the constriction in vocal tract moves backwards, the duration of VOT increases. Here, the distinction between back/non back depend upon raising back of the tongue and nonback and are tongue tip sounds produced with the anterior l/3rd of the tongue. Only nonback sounds can be divided into palatal(+) and non-palatal(-). As the duration of the VOT cannot be considered as binary it was not possible to find acoustic correlates of back and nonback.

Thus both the acoustic and articulatory features have become essential in describing the consonants of

Malayalam language. Further, the tree diagram illustrates the various features required to distinguish the consonants of Malayalam.

From the acoustic analysis, the hypotheses that

- "Each feature has a distinctive acoustic characteristic" is accepted.

A comparison of distinctive features used in the present study for analysis of Malayalam consonants with descriptive analysis of consonants of other languages show that atleast some of the distinctive features are common for all the language. Thus the feature system seems to be universally applicable? Hence the distinctive feature analysis in Malayalam for example will be useful in providing common terms for discussion for the professionals who may not be aware of the analysis. Further, the investigator wishes to use this to develop articulation test in Malayalam.

From the results of the perceptual analysis, the following hypotheses were accepted,

(1) Malayalam language has a distinctive feature system.

(2) It is possible to propose a distinctive feature in Malayalam.

(3) information value carried by each feature varies.

(4) The hypothesis that consonants in Malayalam are made up of the following features was accepted but with a slight modification. Since the features retracted/non-retracted nasals; retracted/non-retracted nonconsonantals and retracted/non-retracted non lateral* non-obstruent are redundant, they will be represented only as retracted/non-retracted.

The proposed features were

(1) Consonantal/non-consonantal,
(2) Obstruent/non-obstruent
(3) Nasal/oral
(4) Continuant/non-continuant
(5) Back/nonback
(6) coronal/non-coronal.
(7) Retroflex/non-retroflex
(8) palatal/non-palatal
(9) Retracted/non-retracted
(10) Voiced/Voiceless
(11) Aspirate/non-aspirate.

These features can be further divided into articulatory and acoustic features.

Articulatory features are

(1) Back/nonback
(2) Coronal/non-coronal

(3) Palatal/non-palatal

(4) Retroflex/non-retroflex

(5) Retracted/non-retracted.

Acoustic features are

(1) Consonantal/non-consonantal

(2) Obstruent/non-obstruent

(3) Continuant/Non-continuant

(4) Nasal/non-nasal

(5) Voiced/Voiceless

(6) Aspirated/Unaspirated.

The following hypotheses were rejected;

(1) No significant difference will be found in the listening performance of Malayalam and non-Malayalam speakers when words with minimal differences are presented in quiet situation.

(2) There is no difference between the Malayalam and non-Malayalam listeners with respect to perception of nasal phonemes.

0*0*0*0*0*0*0*0*0*

Chapter V

SUMMARY AND CONCLUSIONS

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SUMMARY AND CONCLUSIONS

Phoneme was considered to be the smallest unit of language (Bloomfield 1936). This traditional view has undergone a metamorphosis with the advent of the concept of distinctive features. Distinctive features are now considered to be the "physical and psychological realities of a phoneme" (Singh,S. 1976). This definition thus clearly brings to light the two aspects of the features - the perceptual and the acoustic.

The establishment of a distinctive feature system has been achieved by various methodologies such as the perceptual method, articulatory method, acoustic method (Jacobson, Fant and Halle, 1952, Chomsky and Halle 1968, Singh, and Becker, 1971).

Distinctive features serve many purposes -
They can be used to study thoroughly the phonology of a language.
— They can be used to study the acquisition of phonology.
- in assessment and management of articulation disorders.
- To study the perception of individuals who are both normal and hard of hearing.

An attempt has been made to describe Hindi language using distinctive features (Ahmed and Agrawal 1969). Somasundaram (1972) has attempted to compare phonology of four languages - Tamil, Kannada, Malayalam and Telegu

using distinctive feature system of Jacobson, Fant and Halle (1952). However this was not an experimental study. Falguni Pathak (1982) established a destinctive feature system for Gujarathi consonants. Destinctive features of Kannada consonants are also being investigated (venkatesh, 1983). The present study aimed at establishing a destinctive feature system of Maiayalam consonants.

308 minimal pairs were prepared using Malayalam consonants. The minimal pairs were prepared with the help of Gunderts Mikhander in Malayalam (1962). The pairs were prepared such that there is atleast one feature difference between the two pairs of consonants. The perceptual analysis was carried out in two stages-

Part I - The minimal pairs were presented to a group of 30 subjects whose mother tongue was Malayalam. Subjects had to speak out what they heard.

Part II- The same stimuli were presented to a group of 30 listeners who had kannada as their mother tongue.

37 words from the list were selected and spectre—graphic analysis was done. ie. wide band spectrograms were obtained. The perceptual data was analyzed using confusion matrices and by calculating information content of each feature, information content carried by each phoneme was also noted.

The following conclusions were drawn from the study:-

1. Malayalam language has a distinctive feature system.
2. It is possible to propose a distinctive feature system in Malayalam.
3. Consonants in Malayalam are made of the following features:-
   a) Back / nonback
   b) coronal / noncoronal
   c) palatal / nonpalatal
   d) retroflex / nonretroflex
   e) retracted / nonretzacted
   f) consonantal / nonconsonantal
   g) obstruent / nonobstruent
   h) continuant / noncontinuant
   i) nasal / nonnasal
   j) voiced / nonvoiced
   k) aspirate / nonaspirate.

   } Articulatory features

4. information value of each feature differs.
5. Each feature has a distinctive acoustic characteristic.
6. significant differences found between the listening performance of Malayalam and nonMalayalam speakers when words with minimal differences are presented in a quiet room situation.
7. There is a significant differences between Malayalam and nonmalayalam speakers with respect to perception of nasal phonemes, the malayalam speakers performing better.

1. The distinctive feature system thus established gives an indepth analysis into the phonology of Malayalam.
2. It can be used to study the phonological aquisition of Malayalam in children.
3. It has a major implication to articulatory disorders both at the testing and at the therapeutic level.
4. It allows the study of perception of those with Malayalam as their mother tongue and other groups whose mother tongue is not malayalam.
5. The feature system may be helpful in classifying articulation disorders in order of severity; especially using the substitution analysis which may indicate depending upon the substitution, its severity.
6. Speech discrimination may be developed in Malayalam.
7. An articulation drill book in Malayalam can be developed.
8. it can be used in speech synthesizers.

Recommendations:-

1. Further study can be done on substitution analysis, that is which of the features are substituted by the other features, eg- which are the major features substituted for the feature of voicing.
2. An articulation test in Malayalam can be developed on the basis of the distinctive feature system thus established.
3. Distinctive feature system can be developed for vowels in Malayalam.

4. To study the behaviours of non-malayalam speakers with various mother tongues to Malayalam consonants and vowels.

5. Distinctive features can be established using different methodology.

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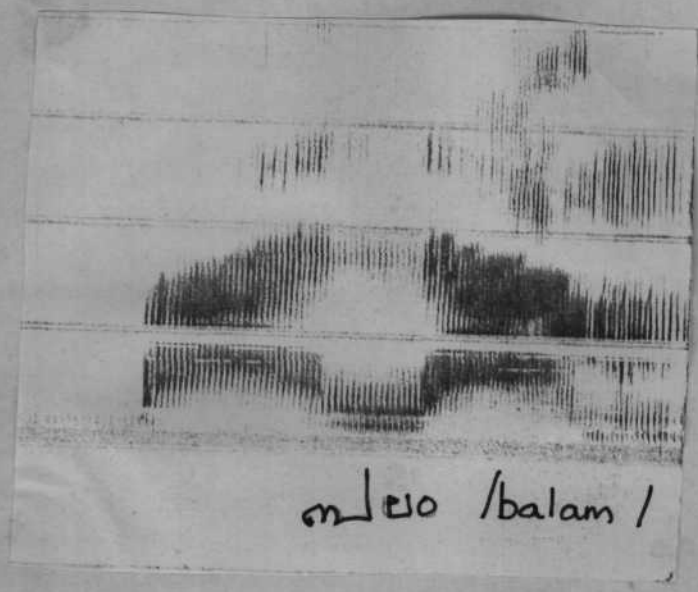
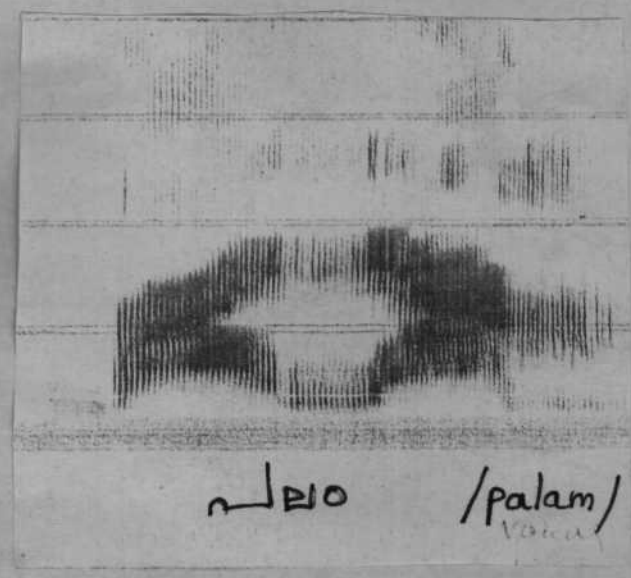
ACOUSTIC ANALYSIS





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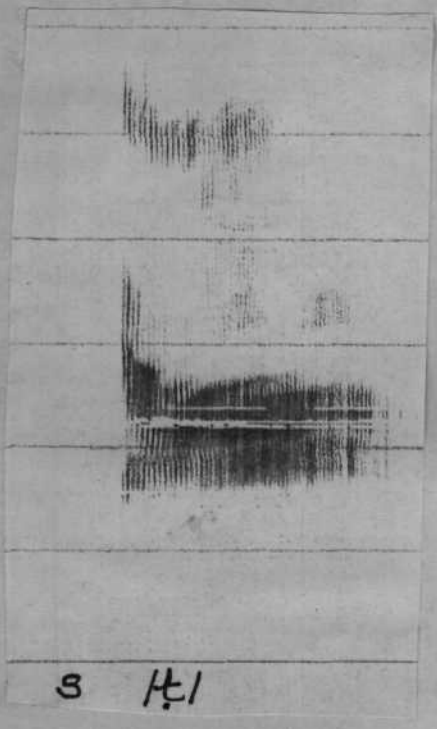

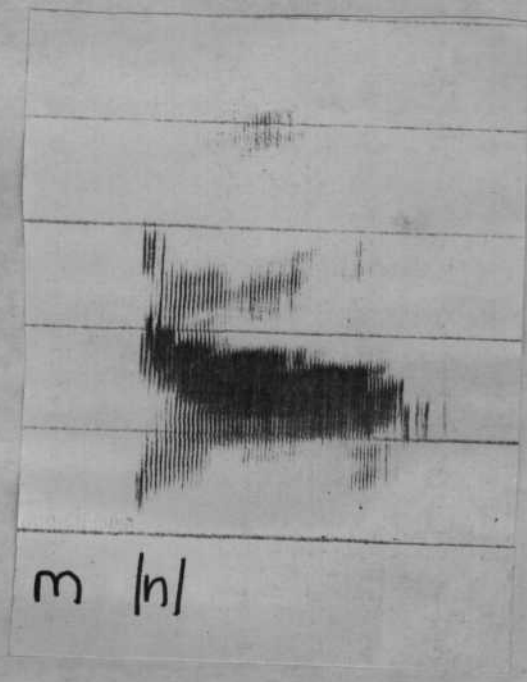

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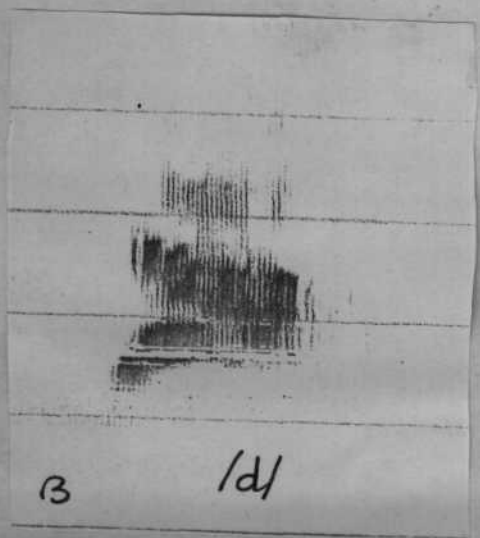

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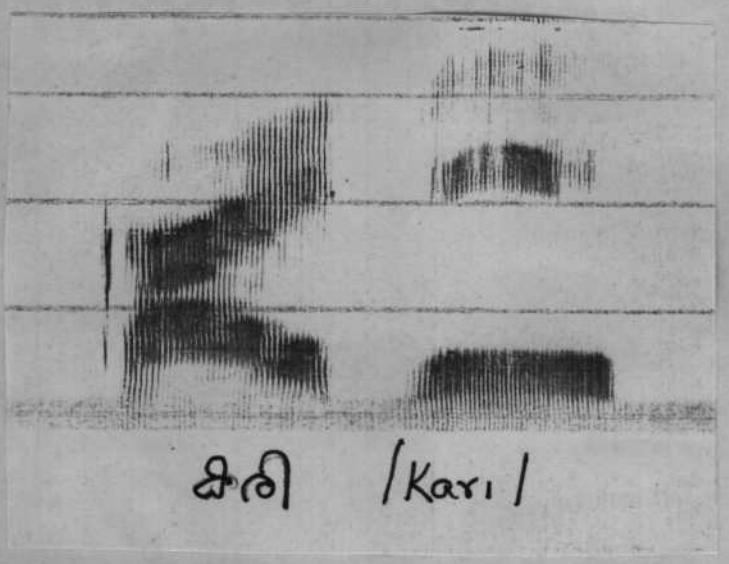

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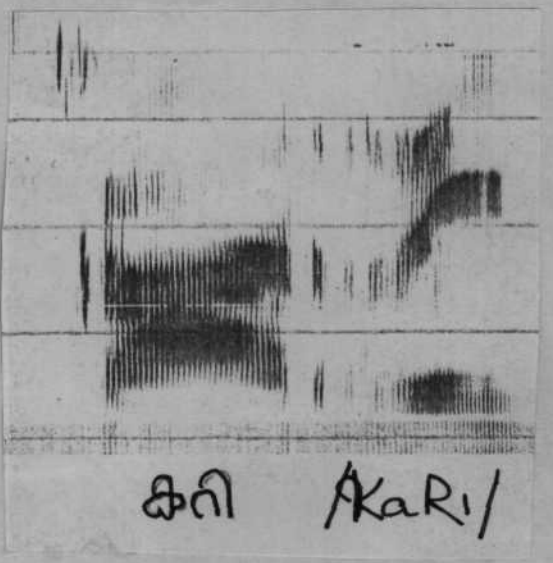

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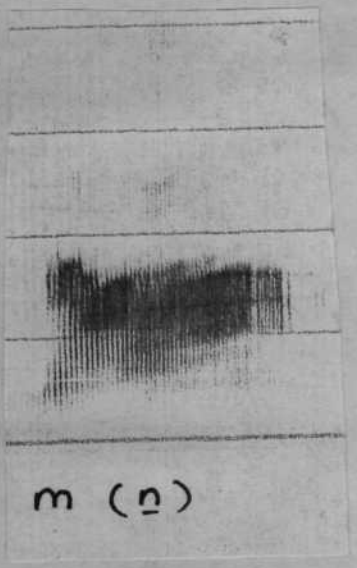

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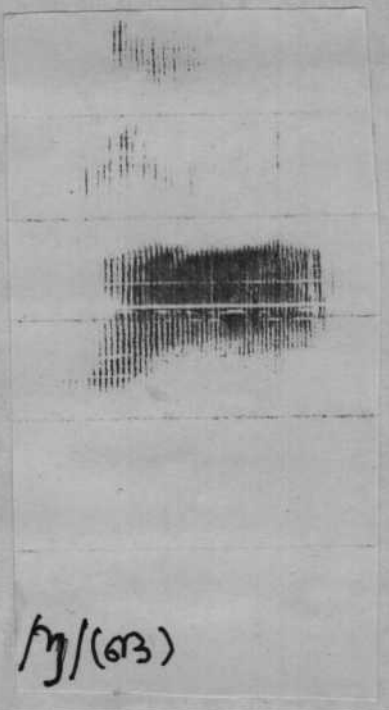

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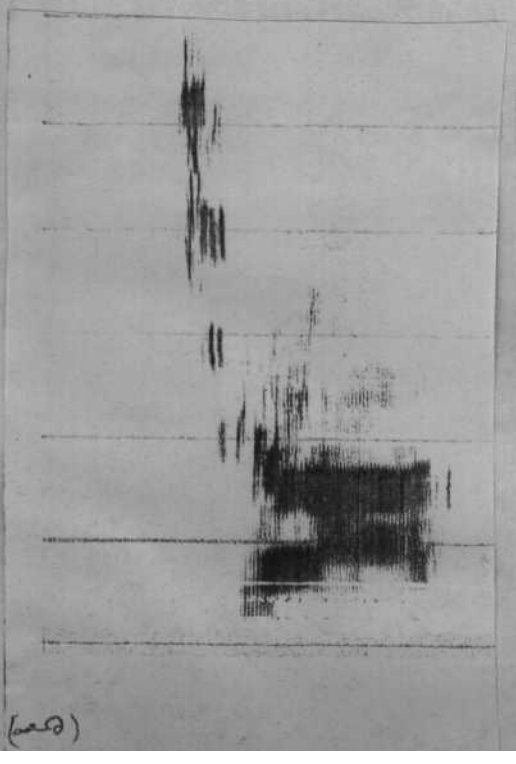

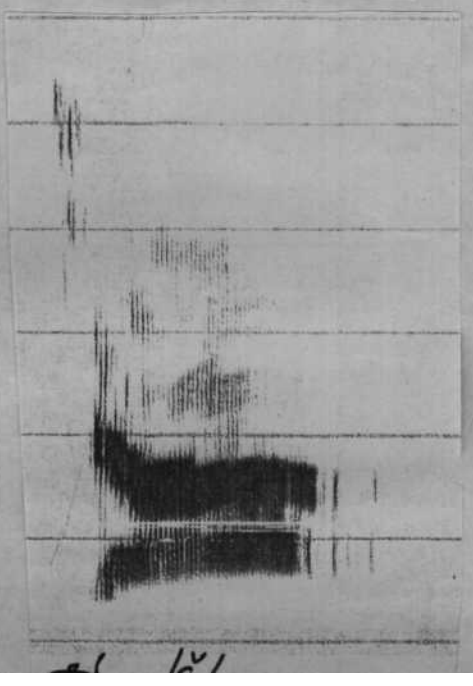

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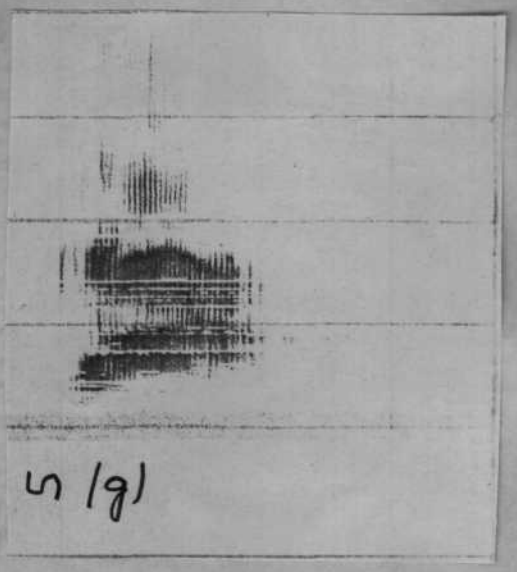

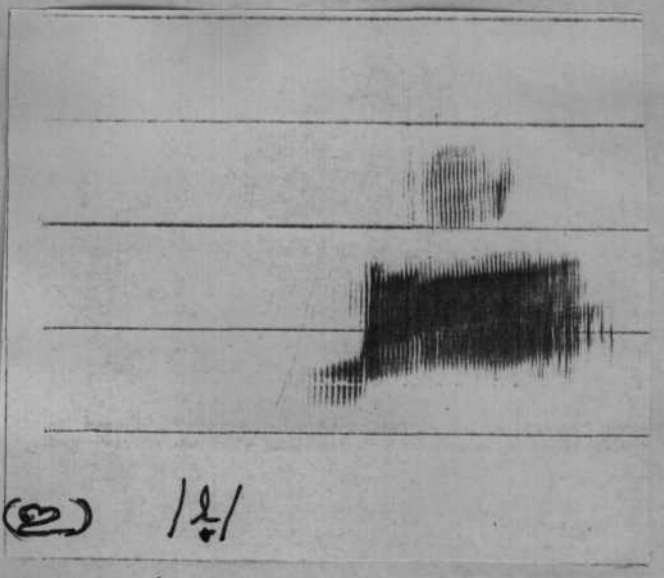

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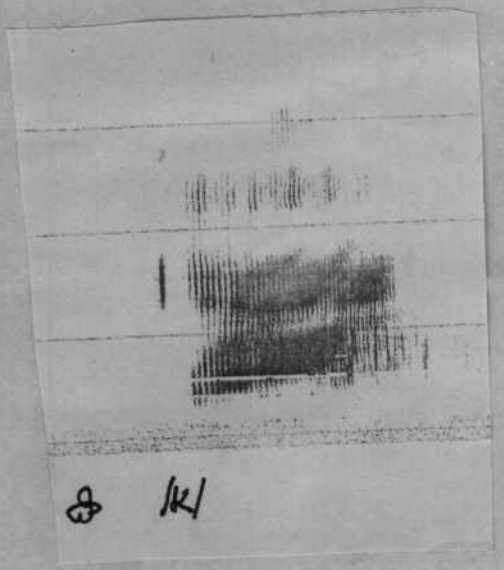
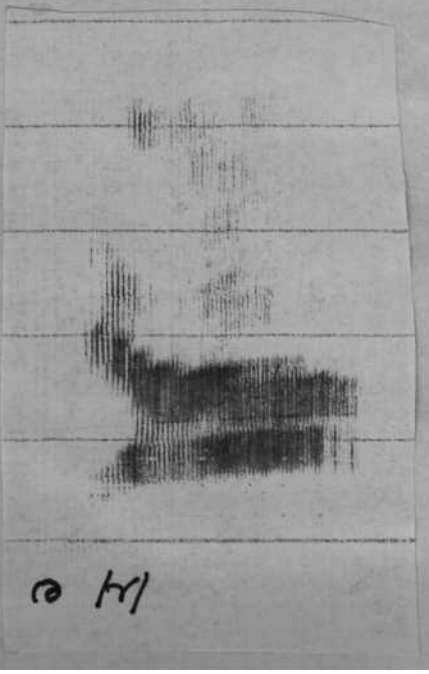
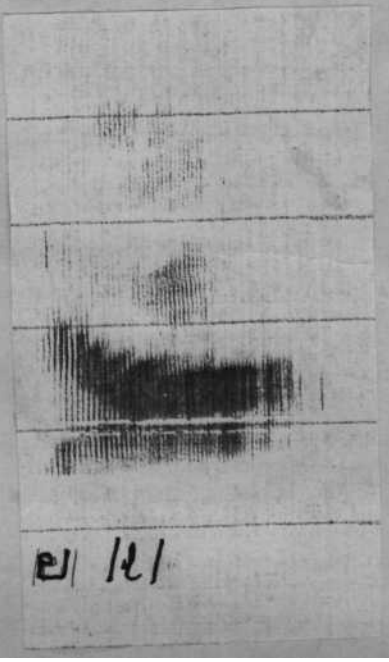
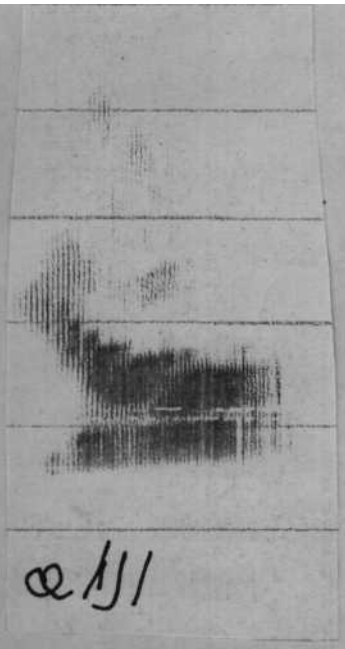


NASAL / NONN





LATERAL / NON LATE



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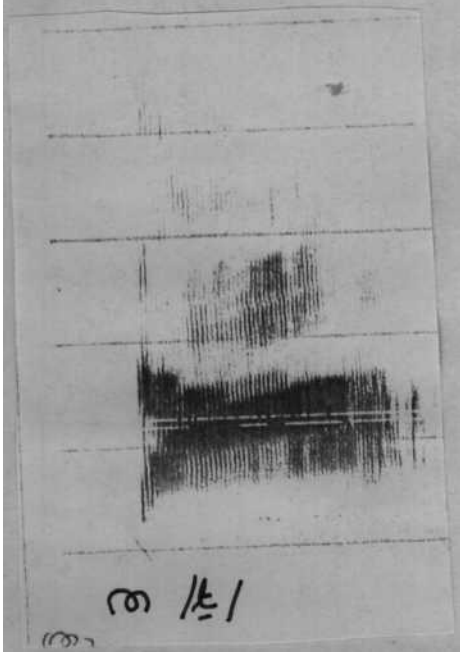
OBSTRUENT /NON
OBSTRUENT



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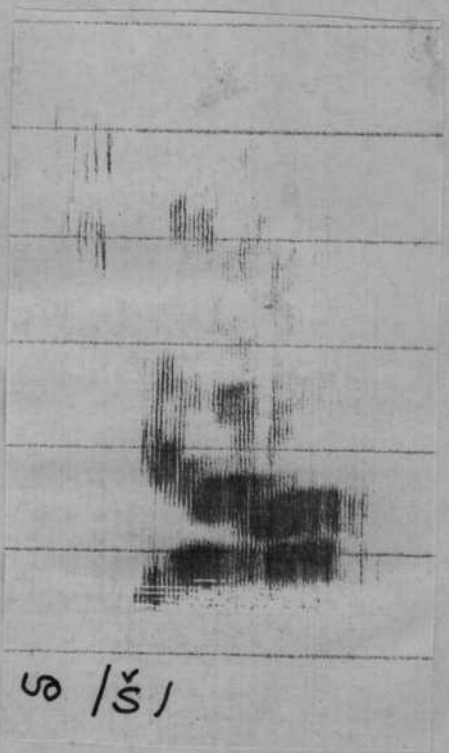

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PALATAL /NONPALA

MINIMAL PAIR LIST

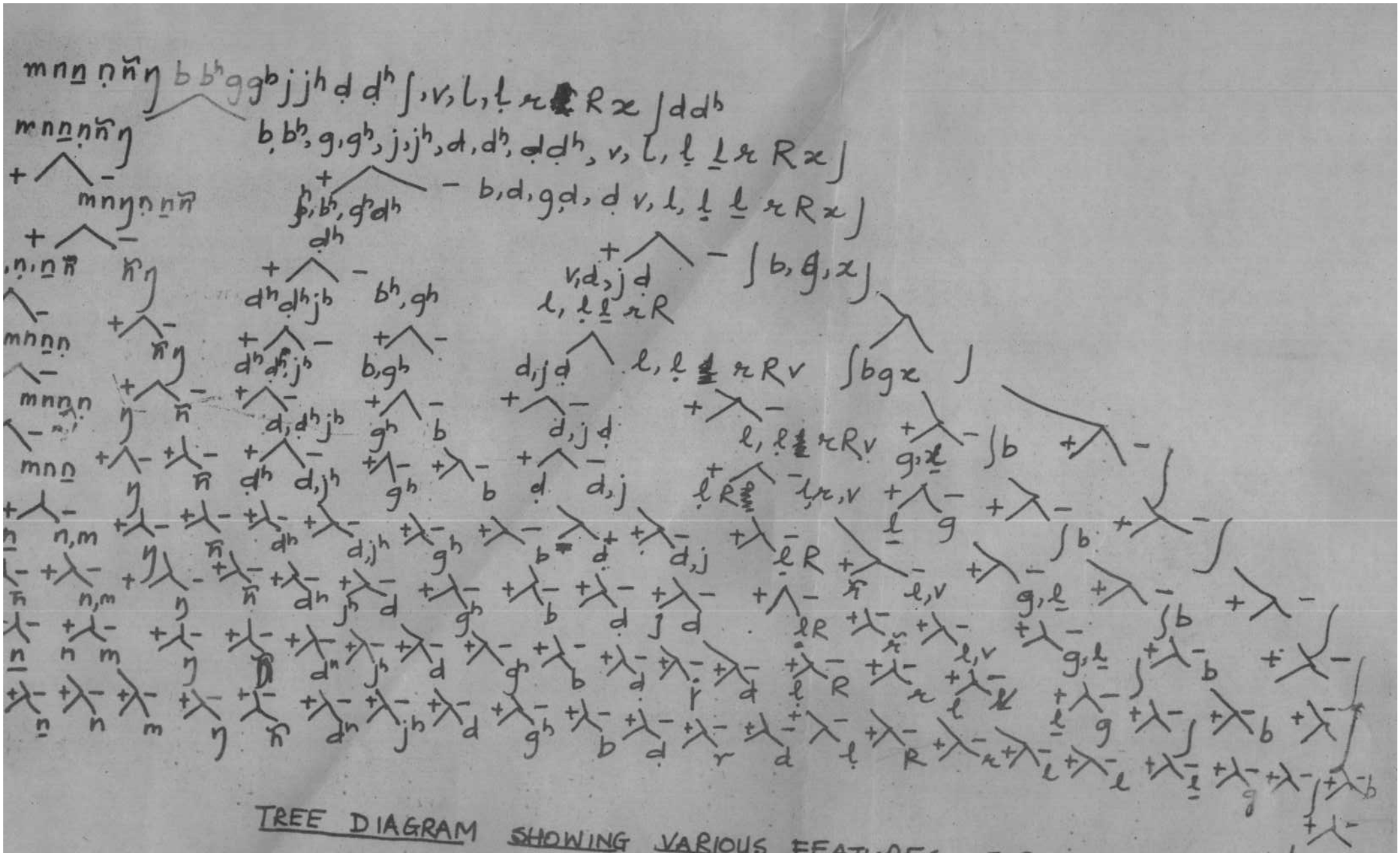
ബലം	പലം	ഫലം	ബലം	ഞണ്ട്	പണ്ട്
ഫതി	ഖതി	ഫാദം	ഫാലം	മരണം	ശരണം
തറ	ഫറ	ഫാദം	ഫാരം	തട	ഫട
ഫട	വട	തടി	കടി	തലം	ബലം
ബാരം	താരം	ഫാപം	ഫാടം	ഫിണം	ഫണം
ഫക്ഷം	ലക്ഷം	മഷി	മതി	മലം	ലലം
മതം	ക്ഷതം	ദേഹം	ഗേഹം	മാലം	താലം
മതി	ഗതി	ഭഗം	നഗം	ബാരം	ഫാരം
മണം	ഫണം	ഫാദം	നാദം	കാരം	കാമം
രതി	സ്വതി	മരണം	ഭരണം	തന്ത്രം	ധന്ത്രം
ഭക്തി	ശക്തി	കരി	കറി	ഫദം	ഗദം
തലം	ഫലം	ബലം	ഹലം	രതി	ഢതി
തകടം	ശകടം	ഭലം	ലലം	ഫാതി	ജ്ഞാതി
ഫലം	മലം	ശങ്ക	ഫങ്ക	രഥം	രസ്യം
സ്വാദം	ഫാദം	രഥം	ഫഥം	മരണം	ഭരണം
താലം	ലാലം	ഭങ്ങി	മങ്ങി	തരി	ഫിരി
ഭാഗം	രാഗം	ബാണം	നാണം	ക്ഷീരം	ജ്ഞാനം
മുഷ്ടി	മുഷ്ടി	തങ്ങി	ഞങ്ങി	രാമ	ഫാമ
ഭക്ഷണം	ലക്ഷണം	കാരം	കാലം	ബ്ലി	കലി
ഫതം	ബതം	ഭൽഫാവ്	കൽഫാവ്	കര	കട
ഭഗം	ലഗം	താനം	ഗാനം	താലം	ജ്ഞാലം
ബലം	ഹലം	മഴ	മമ	ഭലം	നലം
തല	ഫല	ഫാദം	ഫാശം	ഭാരം	ഫാരം
മരണം	വരണം	മലം	നലം	തങ്ങി	ഞങ്ങി
ഭാഗം	ധാഗം	തിരി	ഫിരി	ഫട	കട
ഫഥാ	ധഥാ	വീഥി	വീതി	രോധം	ബോധം

ജമ ജവ	ജാഥ ഗാഥ	യഷ്ടി ഷഷ്ടി
മായം സായം	ചട്ട കട്ട	ഹിതം മിതം
രാത്രി ധാത്രി	ഞാര ജാര	സംഗം ഭംഗം.
തലം മലം	ധരം പരം	ടപ്പ് കപ്പ്
തക്ഷണം ഭക്ഷണം	ചൂടി മൂടി	ക്ഷയം മയം
തണ്ട് , രണ്ട്	ഛിന്നം ഭിന്നം	നോട്ടം തോട്ടം
തമിച്ചു രമിച്ചു	കരം ത്ധരം	പാലിച്ചു പാരിച്ചു.
താരം സാരം	ഖലം ബലം	യാതി ജാതി
രഥം കഥം	ചിരി ഗിരി	ഹരം ചരം
ദായം ചായം	ബരം വരം	യാനം പാനം
പെട്ടു ചെട്ടു	കണ്ടം ഷണ്ടം	തോടി തോഴി
ഭയം കയം	പാകം പാദം	പാട പാവ
ഭരണി സരണി	ബന്ധം ഗന്ധം	സേവ ദേവ
രവം ദവം	കലം ബലം	യാഗം ഭാഗം
തടം വടം	ചത ബത	ഹലം പലം
തരി ഹരി	ചാരി സാരി	നാരം ഭാരം
മണം ഫണം	ധരം കരം	ലോകം ശോകം
കായം റായം	ചട്ടി തട്ടി	പാട പാറ
ധരം പരം	അച്ഛൻ അപ്പൻ	നയം ലയം
ദാനം മാനം	ഞണ്ട് വണ്ട്	സന്ധം ഗന്ധം
ജലം വലം	കാലം പാലം	നീതം ശീതം
കനം ധനം	പദം പലം	ധഞ്ചി മഞ്ചി
ദാരം ചാരം	കരണം ഭരണം	സദാ ഗദാ
ബതി പതി	ഞാവൽ ചാവൽ	യാചകം പാച
ബനി പനി	കാമം യാമം	നൃത്തം വൃത്ത
വനി തനി	കരം ബരം	ഹത ബത
ജലം മലം	ഗതി പതി	പാട്ടി പാറ്റി
ജനം ദനം	പാകം പാതം	കഞ്ഞി കനി

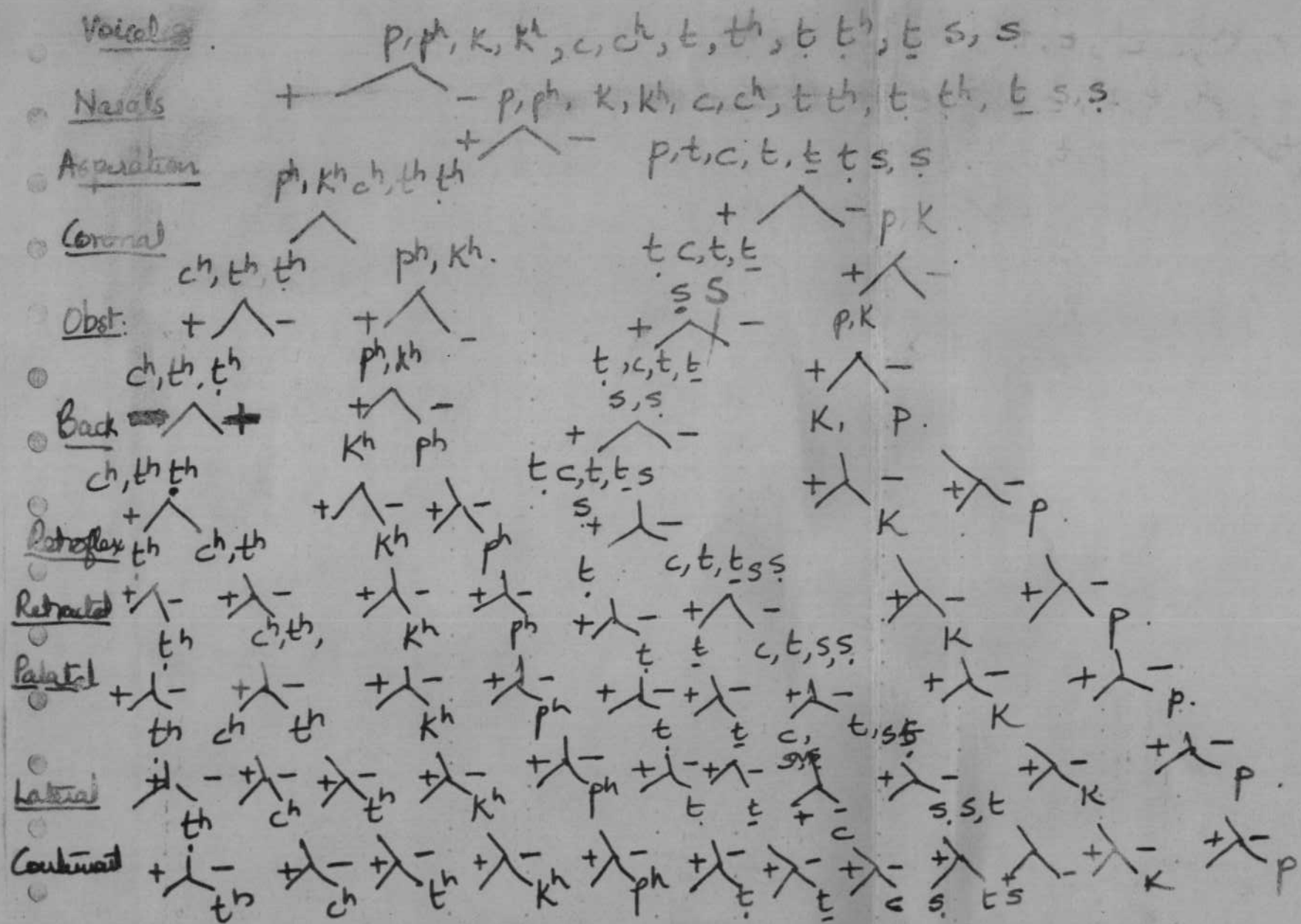
സംഗം രംഗം	ഛവി രവി	ഛലം ഫലം
സിതം ഹിതം	ഞണ്ട് പണ്ട്	ചാമം യാമം
ഹേതു സേതു	കാമം സാമം	ഖണ്ഡം ദണ്ഡം
പാർ പാൽ	ഛവി കവി	പാടി വാടി
ഘടം ജടം	ദശ കശ	ജയം മയം
നയം ഹയം	ജയം ലയം	കാരം ചാരം
ക്ഷയം ലയം	മഞ്ഞ് മഞ്ഞ്	വലം ജലം
തടി തവി	ഖനി കനി	കലം ജലം
മാസം മാനം	ചലം ഫലം	കില ജല
വലി വരി	ഛായ ചായ	ചരണം മരണം
സാട ചാട	ജലം മലം	ചിരി പിരി
ഗാനം താനം	കനി ശനി	കക്ഷം ലക്ഷം
ക്ഷീരം തീരം	ചികി ചിത്തി	ചാടി മാടി
നീതം ശീതം	ഞണ്ട് തണ്ട്	ചലം ഫലം
ക്ഷതം ഗതം	കണ്ട് വണ്ട്	ഞായം ലായം
തടി തവി	ദണ്ട് തണ്ട്	ഞണ്ട് കണ്ട്
യതി പതി	പചിച്ചു പനിച്ചു.	ജലം വലം
പാട പാല	കരി നരി	കാലം ഢാലം
യാനം താനം	കഥം രഥം	ദാതാ മാതാ
ഘടം പടം	ദാതി ജാതി	ജയം നയം
ക്ഷാമം യാമം.	ജ്ഞാതി പാതി	ഞാൻ മാൻ
ദാരം ഭാരം	ധനം മനം	യതി മതി
കളം ഗളം	ദാനം പാനം	ഘനം മനം
ക്ഷയം കയം	ഞങ്ങൾ തങ്ങൾ	ശിരം ചിരം
കണി മണി	ചകി പകി	ക്ഷതം യതം
ചരണം ശരണം	കലം ഫലം	പാരം ജാരം
ഛവി തവി	ഖലം മലം	ഖഡ്ഗി ഷഡ്ഗി
ഖനി ശനി	കട ഛട	ഘടം കടം
കടം ഘടം	പാദം പാനം	ഘനം മനം
	കങ്കണം ടങ്കണം	നാക്ക് കാക്ക്
	കണ്ട് ഞണ്ട്	

ചാരണം	ടരണം
ചാട	ചാര
ചടം	വടം
ചാനം	ചാകം
ചാരം	താരം
സന്നി	കന്നി
മന്ത്രം	തന്ത്രം
തുടി	തുറി
ചാടി	ചാണി
പക്ഷി	ചന്തി
ചാനി	കനി
ക്ഷിമം	ലയം
ചക്ക്	ചണ്ണ്
മാമം	സാമം
ശവം	ശരം
മക്ഷിൻ	തക്ഷിൻ
ചടി	ചഴി
നെഞ്ച്	മെഞ്ച്
ലവം	രവം
സൃഷ്ടം	ദൃഷ്ടം
ലേവ	രേവ
സാരി	ചാരി
വത്ത	കത്ത
ചമം	ക്ഷിമം
ക്ഷീരം	വീരം
താല	ചാല
ജ്ഞാപം	ജ്ഞാലം
ചലം	വലം
നട	ഗട

നാല	ബാല
ഗതി	ചതി
കാസം	കാലം
സിതം	ജിതം
സംഗം	വംഗം
ദുഃഖം	ക്ഷുഃഖം
ചത	ചല
ചാലം	ചാകം
ലോകം	ശോകം
ക്ഷീരം	തീരം
നയം	ജയം
താരി	ചാരി
കക്ഷി	കനി
മണ്ണ്	മക്ക്
ചലം	ചടം
മടി	മതി
തേടി	തേനി
ഡാലം	കാലം
ഠാലം	കാലം
ചടം	ചണം
കടൽ	കണൽ



TREE DIAGRAM SHOWING VARIOUS FEATURES FOR VOICED CONSONANTS IN MALAYALAM



TREE DIAGRAM SHOWING VARIOUS FEATURES FOR VOICELESS CONSONANTS IN MALAYALAM